Saskatchewan
Environment

Chemical Waste Inventory Report

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Saskatchewan Environment
1855 Victoria Avenue
5th Floor
Regina, Saskatchewan
S4P 3V5

Attention: Mr. D. Clark, P. Eng.
Waste Management Engineer

Province of Saskatchewan
- Chemical and Industrial
Waste Inventory

Dear Sirs:

We are pleased to submit our report on chemical waste inventory for Saskatchewan. This report summarizes the results of our survey of some 495 industries and agencies. A high response was achieved with data received from some 318 respondents. This represents an overall response rate of 65%. We believe that the data provided herein provides a sound basis for the development of a chemical waste management stragegy for the Province and provides a bench mark estimate for the proposed waste manifest system.

We would be most pleased to further elaborate on the results of our detailed work and look forward to our continued involvement in Saskatchewan waste management programs.

Yours very truly,

M. M. DILLON LIMITED

P. C. Murray

PCM:mw
Encls.

Paul C. Murray, P. Eng.
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ABSTRACT

This study summarizes the results of a questionnaire survey of 495 industrial concerns and agencies in Saskatchewan. The objective of the study was to establish bench mark data on current (1981) chemical waste generation and disposal in the Province of Saskatchewan.

Overall response rates of 65% (by company) and 80% (by employment) were achieved. The number of waste streams reported was 323 totalling 16 640 tonnes/year of wastes. Based on the response rate by industry groups and analyses of reported wastes, the estimated total chemical waste generation for the Province is 22 800 tonnes/ year. By 1985 the total is expected to increase to 24 400 tonnes/year, and by 1990, 26 600 tonnes/year.

The reported and estimated waste data is summarized by:

- SIC group
- waste type
- disposal method
- geographic distribution

Treatment and disposal options considered for a provincial waste management strategy based on reported wastes are discussed and include:

- waste recovery/reclamation
- thermal destruction
- land disposal
- physical/chemical treatment and waste recovery/ reclamation
- physical/chemical treatment and thermal destruction
- physical/chemical treatment and land disposal
- specialized treatment technology

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1. INTRODUCTION

1.1 Background

For a number of years the Province of Saskatchewan has been concerned with the growing volume and variety of chemical wastes generated and/or disposed of within the province.

In general, Saskatchewan's concerns can be categorized within the following broad questions:

- What types of chemical wastes are generated in Saskatchewan; what are the volumes; and where are the sources of generation?
- What are the current disposal practices for the chemical wastes; where, how and in what volumes are wastes disposed of?
- What disposal options are available for chemical wastes generated in Saskatchewan?
- Are the current chemical waste disposal practices adequate and environmentally sound; is there a need to investigate other options?
- What overall chemical waste management strategy should the Province of Saskatchewan adopt?

With the growing concerns about chemical waste disposal in Saskatchewan and in neighbouring jurisdictions, several studies have been undertaken to attempt to answer some of the preceding questions. Among the recently completed studies are:

- "Hazardous Wastes in Northern and Western Canada "(1)

  Funded jointly by Saskatchewan, Alberta, Manitoba, the Northwest Territories, Ontario, British Columbia and the Federal Government; the study objective was to develop an overall waste management strategy for Western Canada (from the Pacific to Lake Superior).

  Completed in 1980, the study provided general information on volumes and types of chemical wastes generated in Saskatchewan and identified a broad hazardous waste management strategy within a five province context.

- "Inventory of Waste Oil in Saskatchewan" (2)

  Funded jointly by Saskatchewan and the Federal Government, the study objective was to determine waste oil generation within the province with a view to potential waste oil recovery.

  Completed in 1979, the study involved a direct questionnaire survey of a sample of sellers and users of lubricating oil.

It was recognized by Saskatchewan Environment, that the preceding studies represented two fundamentally different approaches to answering the basic questions on chemical wastes in the province:

- The "Western Canada" study provided a broad overview of Saskatchewan's practices and problems within the context of a five province review - a picture dominated by waste generation in Alberta and British Columbia.

- The "Waste Oil" study provided a narrow in-depth review of the generation and disposal of one specific waste in Saskatchewan.

In the context of provincial requirements, Saskatchewan Environment desired greater detail for the broad range of waste estimates developed in the "Western Canada" study.

Consequently, in September 1981, Saskatchewan Environment authorized M. M. Dillon Limited to develop a manifest system for tracking of chemical wastes in the province and to undertake a province-wide inventory of chemical waste generation and disposal. The intent of this twofold assignment was to:

1. Develop a system of monitoring future chemical waste generation and disposal by tracking movements of waste materials in the Province of Saskatchewan - the manifest system.

2. Establish benchmark data on current (1981) chemical waste generation and disposal practices in the Province of Saskatchewan - the inventory.

The "Chemical Waste Manifest System" report (3) was submitted to Saskatchewan Environment in March 1982. The following document presents the results of the inventory.

1.2 Inventory Objectives

As previously stated, the intent of the inventory is to "establish benchmark data on current (1981) chemical waste generation and disposal in the Province of Saskatchewan".

More specifically, the inventory is intended to address the previously stated questions of:

- What types of chemical wastes are generated in Saskatchewan; what are the volumes; and where are the sources of generation?

- What are the current disposal practices for the chemical wastes; where, how and in what volumes are wastes disposed of?

- What disposal options are available for chemical waste generated in Saskatchewan?

The inventory is not intended to address the remaining two questions posed in Section 1.1:

- Are the current chemical waste disposal practices adequate and environmentally sound?

- What overall chemical waste management strategy should the Province of Saskatchewan adopt?

Answers to the latter two questions require a detailed assessment of the adequacy of present waste disposal practices and the regulatory framework within which the present practices exist. Such an assessment is beyond the scope of this study.

In summary, the objective of this inventory is to provide a detailed data base upon which a waste management strategy for the handling, treatment and disposal of chemical and industrial wastes and waste oils can be developed for the Province of Saskatchewan.

1.3 Approaches to Waste Inventories

Depending on the desired level of accuracy and the study objectives, there are two basic approaches to undertaking a waste inventory:

- Indirectly or theoretically, by determination of estimated waste types, character and quantities for classes of industry based on experience from previous

studies or from published technical literature. The theoretical unit waste generation rates are adjusted to the study area conditions by relating to a measurable quantity such as number of production employees or product quantities.

The indirect approach is relatively straight forward and requires a moderate level of effort. It is commonly used for broad overviews, such as "Hazardous Wastes in Western Canada" (1), where the required level of detail is not high.

- Directly, by survey and reporting of waste streams for selected industries.

  The direct approach requires a higher level of effort, but provides a much higher level of detail including industry-specific and site-specific data on process, disposal methods, and effectiveness of present disposal practices.

In undertaking this inventory, data was acquired first by direct survey. Subsequently, the acquired survey data was compared with secondary source information in order to detect anomalies and make any required adjustments.

1.4 Terms of Reference

In the context of the inventory objectives, the following terms of reference were developed:

- Review existing relevant information on waste generation and disposal in Saskatchewan.

- Identify and categorize industry groups and other sources which most significantly contribute to the generation of industrial and chemical wastes and waste oils in the Province of Saskatchewan.

- Identify and categorize the significant industrial, chemical and waste oil streams in the Province of Saskatchewan.

- For selected industries and other establishments undertake a direct questionnaire survey requesting data on:

    - waste character
    - waste quantity
    - generation and disposal locations
    - present disposal practices
    - future waste projections

- Review the responses from the questionnaire survey, follow up on non-responders, and undertake selective verification of suspect returns.

- Summarize the reported waste data by:

    - SIC group
    - waste type
    - disposal methods
    - geographic distribution

- Estimate the total waste streams presently generated in Saskatchewan by factoring reported waste data.

- Project the total waste generation by waste stream for the years 1985 and 1990.

- Identify treatment/disposal options, and segregate the waste estimates into broad streams suitable for treatment/diposal by the available options.

1.5 Significant Exclusions

In consultation with Saskatchewan Environment, the following significant waste streams were excluded from the mainstream of the inventory:

- brines
- waterworks and softening sludges (but not industrial sludges)
- on-farm handling of agricultural chemicals
- ash
- mercury contaminated water
- slag
- household wastes
- mine tailings
- radioactive wastes
- oil and gas drilling wastes
- urea formaldehyde wastes

Exclusion of the preceding streams was based on their general incompatibility with a comprehensive chemical waste management strategy. Further comments on some of these waste streams are provided in Appendix I.

2. SURVEY IMPLEMENTATION

2.1 General

Careful design and management of the direct survey is required to attain the stated objective of providing "a detailed data base upon which a waste management strategy ... can be developed". Important considerations include:

- judicious selection of the industries and agencies to be surveyed (survey design),
- precise definition of the waste streams to be included and excluded (a problem in view of the variety of definitions of "hazardous wastes", "special wastes", "industrial wastes" and "chemical wastes" in different jurisdictions),
- careful design of the survey questionnaire (to obtain comprehensive information, to encourage a high rate of response, and to enable computerized sorting of the data returns), and
- on-going survey management (to monitor response rates, completeness and consistency of returns etc., and to identify follow-up requirements).

Prior to implementing the survey, a review of existing relevant information was carried out, including:

- previous waste studies (both within and outside Saskatchewan) (1) (2) (3) (4) (5) (6)
- industrial indexes and classification systems (7) (8) (9)
- demographic publications (10)
- waste classification systems (3) (11) (13)

2.2 Survey Design

As a first step in survey design, a master listing of potential waste generators was prepared. The basis for establishing this list was as follows:

- All known Saskatchewan industrial concerns were to be included.

  The primary source of information for industries was the "1979 Saskatchewan Manufacturers Guide" (7). Information from the preceding source was also supplemented by information from industrial directories for Saskatoon (9) and Regina and from a 1981 update to the Manufacturers Guide (which became available in draft form later in the study).

- A 10% sample of selected service establishments was to be included.

Hospitals, vehicle repair shops, cleaners, etc. were to be included in this category.

- A number of associations, crown corporations, education establishments and miscellaneous agencies (selected by Saskatchewan Environment) were to be included.

  The purpose of this section of the master listing was to include potential sources of data which would complement or augment information obtained from the industrial concerns and service establishments.

The completed initial master listing included some 900 entries.

As a second step in survey design, the industrial concerns and agencies on the master listing were sorted into standard industrial classifications as follows:

- The Canadian Standard Industrial Classifications System (SIC) (8) was used to categorize all entries on the master list.

  Unfortunately, the Canadian SIC system, while generally conforming to the international (ISIC) system, varies somewhat from the American SIC system. While the Canadian SIC system is most applicable for correlating Saskatchewan data with other Canadian information, it precludes easy direct comparison with very relevant American studies such as the New York State Study (4).

- **For purposes of data base management in this study, the Canadian SIC system was modified to a uniform 4-digit code.**

  The Canadian SIC system comprises 3-digit and 4-digit identifications. Three-digit classifications were converted to 4-digit categories (e.g. 001 to 0010).

The 900 entries on the master listing were thus sorted into 84 standard classifications.

As a third step in survey design, the 84 industrial classifications were categorized into four broad groups. These groups, established on the basis of anticipated differences in waste generation characteristics (and therefore survey requirements), are as follows:

- Group A - Process Industries is comprised of industries characterized by the generation of liquid chemical wastes or contaminated wastewater, or by the use of bulk chemicals for manufacturing. A significant portion of the total waste stream was expected from this group; therefore, technical review and follow-up was emphasized for these industries.

  Group A comprised 27 classifications with 86 addresses surveyed.

- Group B - Non-process Industries is comprised of industries which are likely to generate chemical and industrial wastes on a batch basis and in small quantities. Based on previous American experience (12) it was expected that many industries within this group would not generate any wastes at all, in particular, those industries with few employees. In an effort to limit the number of Group B industries surveyed and to avoid surveying those with very little manufacturing activity, those with five employees or less, as listed in the manufacturers guide, were excluded from the survey.

  Group B comprised 38 classifications with 328 addresses surveyed.

- Group C - Case Study Classification. It is recognized that certain chemical wastes and waste oils are generated from a variety of "non-manufacturing" activities; however, these operations are small and numerous. It was not expected that the quantities and types reported by different firms within each grouping would vary significantly; thus, a statistical approach was considered appropriate and selected. For these groups, a sample rate of one in ten was selected.

  It is considered that the nature of these businesses is consistent enough that such an approach would provide representative data on waste streams generated by the sector as a whole. Of interest

were streams such as cleaning solvents, photo chemicals, cutting oils and paint residues.

Group C comprised 5 classifications with 34 addresses surveyed.

- Group D - Government and Miscellaneous Classifications is comprised of a selected number of associations, crown corporations, oil re-refiners, educational establishments, cities, airports, and agricultural research facilities. These were surveyed to provide data on wastes generated through their own operations or data which may assist in verifying other returns.

  Group D comprised 14 classifications with 47 addresses surveyed.

In summary, with the trimming of the very small non-process concerns in Group B, the final survey design was as follows:

- 495 industrial concerns and agencies in the sample
- 84 standard industrial classifications covered
- 4 broad groupings depending on anticipated waste generation characteristics.

The industrial classifications and groupings are presented in Table 1.

TABLE 1
CHEMICAL AND INDUSTRIAL WASTE INVENTORY CLASSIFICATIONS SURVEYED

GROUP A • PROCESS INDUSTRIES

SIC	Classification
0370	Uranium Mines
0610	Coal Mines
0790	Miscellaneous Non-metal Mines
0794	Potash Mines
1090	Beverage Industries
1093	Breweries
1720	Leather Tanneries
2591	Wood Preservation Industries
2593	Miscellaneous Wood Industries
2710	Pulp and Paper Mills
2920	Steel Pipe and Tube Mills
2940	Iron Foundries
2980	Metal Rolling, Casting and Extruding, N.E.S.
3010	Boiler and Plate Works
3020	Cement Manufacturers
3060	Glass and Glass Products Manufacturers
3091	Refractories Manufacturers
3651	Petroleum Refineries
3652	Manufacturers of Lubricating Oils and Greases
3690	Miscellaneous Petroleum and Coal Products Industries
3720	Manufacturers of Mixed Fertilizers
3750	Paint & Varnish Manufacturers
3780	Manufacturers of Industrial Chemicals
3782	Manufacturers of Industrial Chemicals (Inorganic), N.E.S.
3783	Manufacturers of Industrial Chemicals (organic), N.E.S.
3790	Miscellaneous Chemical Industries
3799	Miscellaneous Chemical Industries, N.E.S.

Notes:

* Case Studies.

N.E.S. - Not Elsewhere Specified.

GROUP B • NON-PROCESS INDUSTRIES

SIC	Classification
0310	Logging
1623	Tire and Tube Manufacturers
1650	Plastics Fabricating Industry, N.E.S.
1880	Automobile Fabric Assessories Industries
1890	Miscellaneous Textile Industries
2610	Household Furniture Manufacturers
2860	Commercial Printing
2890	Publishing and Printing
3020	Fabricated Structural Metal Industry
3030	Ornamental and Architectural Metal Industry
3031	Metal Door and Window Manufacturers
3039	Ornamental and Architectural Metal Industry, N.E.S.
3040	Metal Stamping, Pressing and Coating Industry
3041	Metal Coating Industry
3042	Metal Stamping and Pressing Industry
3070	Heating Equipment Manufacturers
3080	Machine Shops
3090	Miscellaneous Metal Fabricating Industries
3110	Agricultural Implements
3150	Miscellaneous Machinery and Equipment Manufacturers
3180	Office and Store Machinery Manufacturers
3240	Truck Body and Trailer Manufacturers
3241	Truck Body Manufacturers
3242	Non-commercial Trailer Manufacturers
3243	Commercial Trailer Manufacturers
3250	Motor Vehicle Parts and Access Manufacturers
3280	Boatbuilding and Repair
3290	Miscellaneous Vehicle Manufacturers
3350	Communications Equipment Manufacturers
3360	Manufacturers of Electrical Industrial Equipment
3380	Manufacturers of Electric Wire and Cable
3590	Miscellaneous Non-metallic Mineral Product Industries, N.E.S.
3911	Instrument and Related Products Manufacturers
3913	Orthopaedic and Surgical Appliances Manufacturers
3930	Sporting Goods and Toy Industries
3931	Sporting Goods Manufacturers
3995	Stamp and Stencil (Rubber and Metal) Manufacturers
6230	Wholesalers of Machinery and Equipment, N.E.S.

GROUP C • CASE STUDY GROUP

SIC	Classification
1629	Miscellaneous Rubber Products Manufacturers*
6380	Motor Vehicle Repair Shops*
8210	Hospitals*
8740	Cleaners*
8930	Photographic Services, N.E.S.*

GROUP D • GOVERNMENT AND MISCELLANEOUS

SIC	Classification
0010	Experimental Farms
5010	Air Transport
5030	Railway Transport
5080	Urban Transit Systems
5150	Radio and Television Broadcasting
5720 and 5740	Electric Power & Gas Distribution
5790	Other Utilities
8050	Post-secondary, Non-University Educational Institutions
8060	Universities and Colleges
8910	Labour Organizations and Trade Associations
9020	Defence Services
9310	Provincial Administration
9510	Local Administration

2.3 Waste Categorization

A fundamental requirement of any chemical waste inventory is prior determination of what constitutes a "chemical waste" or "hazardous waste". At present there are no regulatory definitions in Saskatchewan.

Bearing in mind the present lack of regulatory definition, it becomes necessary to prejudge the waste streams which may require controlled treatment and disposal. Obviously some waste streams are not suitable for handling by a waste management system, and can probably be best dealt with by the generator. For example:

- on site treatment and disposal are dictated for large quantities of industrial wastewaters and mine tailings,

- certain types of wastes are most amenable to concentration (waterworks sludges), treatment or re-use by the generator.

The waste categorization system selected for this inventory is essentially the one outlined in Dillon's "Chemical Waste Manifest System" report (3). This system was developed as follows:

- The classification system was primarily based on the "Transportation of Dangerous Goods Act" (11) (TDGA) hazardous waste listings.

- The TDGA listings were modified where necessary to emphasize environmental hazards (as opposed to transportation hazards).

- The TDGA listings inappropriate to Saskatchewan wastes were deleted, and additional appropriate listings from Ontario's "Classification Guideline for Hauled Liquid Industrial Wastes" (13) were added.

- Classification names were modified as necessary to ensure clarity to both generators (who would identify wastes primarily by production process) and disposers (who would classify wastes by treatment process).

The resulting waste classification system is shown in Table 2.

2.4 Questionnaire Design

The acquisition of data was achieved primarily by mail-out and return of a "Chemical and Industrial Wastes and Waste Oil Survey". Data requested in the questionnaire is itemized in Table 3.

Three versions of the questionnaire were developed:

- "A" version which included all data requests shown in Table 3.

  This version was developed for Group A (Process Industries) and Group D (Government and Miscellaneous Classifications).

TABLE 2

CHEMICAL AND INDUSTRIAL WASTE CATEGORIZATION

WASTE OIL

OILY WASTES
- Crude tank bottoms
- Asphalt emulsions
- Oil and water
- Hydrocarbon condensate
- Oily sludge
- Waste vegetable oils

PLANT AND ANIMAL WASTES
- Fats
- Wood sugars, fibres and grit

ACIDS

PICKLE LIQUOR

ALKALIS
- Spent caustic
- Lime sludge
- Metal cleaners
- Amine and ammonia waste

SPENT CATALYST WASTES

METAL SLUDGES

MERCURY
- Mercury-contaminated soil

CYANIDE

SULPHUR

ORGANIC SOLVENTS
- Xylene, acetone, ethyl acetate, ethylbenzene, ethyl ether, methyl isobutyl ketone, n-butyl alcohol, cyclohexanone, methanol aliphatic, aromatic hydrocarbon solvents (incl. varsol), still bottoms

CHLORINATED SOLVENTS
- Tetrachloroethylene, trichloroethylene methylene chloride, 1,1,1-trichloroethane, carbon tetrachloride, chlorinated fluorocarbons, sludges from degreasing and still bottoms from recovery

PLASTIC RESINS

PAINT AND PIGMENTS
- Paint and ink sludge
- Paint residue (solid)

PHOTOCHEMICALS

WOOD PRESERVING WASTES
- Copper cadmium arsenate

PCB's

PESTICIDES
- toxic liquid
- toxic liquid, flammable
- toxic solid
  (including rinsing, floor washings and containers)

HERBICIDES

PHENOLS (including pentachlorophenol)

SOLID WASTES, N.O.S.

ASBESTOS

HOSPITAL WASTES

TABLE 3

CHEMICAL AND INDUSTRIAL WASTES AND WASTE OIL SURVEY
Questionnaire Design

COMPANY DATA (All questionnaires)

- company name and address
- SIC code
- telephone
- contact name and title

PROCESS DATA (Not included in "B" questionnaire)

- raw materials
- products
- process description
- process flow design

WASTES SURVEY (All questionnaires)

- types and sources
- composition
- disposal method and location
- pretreatment
- projections

SUPPLEMENTARY INFORMATION (All questionnaires)

- oily wastes
- wastewater sludges
- air pollution control wastes
- degreasing and cleaning solvents
- lagoon cleanout
- off-specification products
- PCBs

- "B" version which excluded process data from the request shown in Table 3.

  This version was developed for Group B (Non-Process Industries).

- "C" version which included all data requests expect process data shown in Table 3, and contained data examples relevant to non-manufacturing industries such as photographic finishers, machine shops and autobody repair shops.

  This version was developed for Group C (Case Study Classification).

To assist respondents in understanding the nature of response required, typical response examples were given on the questionnaire form. In addition, a contact name was identified on the covering letter to provide clarification of the questionnaire requirements, if needed.

All questionnaires were sent with a covering letter signed by Saskatchewan Environment's Deputy Minister and outlining the objectives of the program and the need for an improved waste management system. Where a specific request for information was required, an additional covering letter by the consultant was prepared.

A sample covering letter and "A" version questionnaire are included in Appendix II.

2.5 Survey Management

Some 495 questionnaires were sent out to industrial concerns and other agencies. In order to monitor response rates, completeness of responses, and requirements for follow-up, specific survey management data were maintained and updated on an electronic data base.

The data established for survey management comprised:

- a company identification number
- standard industrial classification number
- company name, address, city, telephone, postal code
- name and title of respondent
- number of employees
- date survey sent
- date survey received
- follow-up required
- completeness of data code
- type of questionnaire sent

The emphasis for follow-up was initially aimed at increasing the overall response rate by telephoning all non-respondents. Subsequently, follow-up calls were limited to non-responding process industries only, because they were considered the most significant and variable generators from a waste management standpoint.

Over 100 telephone contacts were made in this follow-up program and over 50 per cent of these calls resulted in identification of additional waste streams.

In some cases, a second questionnaire form was sent to those industries which reported that the original survey could not be located or had been discarded.

2.6 Response Statistics

Past experience indicates that response rates of 20 to 30% may be expected from similar surveys. An overall response rate of 65% was achieved for this study. The responses by groups surveyed are as shown on Table 4.

TABLE 4
RESPONSE STATISTICS

	SIC Groups Surveyed	Addresses Surveyed	Number of Responses	Response Rate %	Number of Waste Streams
Group A - Process Industries	27	86	54	63	60
Group B - Non-process Industries	38	328	219	67	181
Group C - Case Studies	5	34	12	35	34
Group D - Government and Miscellaneous	14	47	33	70	48
	84	495	318	65	323

In reviewing the preceding response statistics, it should be noted that:

- 4 respondents reported that they were no longer in business
- 12 surveys were returned by the post office because the firms were no longer at the given address
- 18 non-respondents were no longer listed in telephone directories, and
- 85 respondents reported that they did not generate chemical and industrial wastes.

Since the bulk of waste generation is expected from Group A (Process Industries), their high response rate (63%) implies a high degree of confidence in waste totals developed later in this report.

3. DATA ANALYSIS AND VERIFICATION

3.1 General

The Terms of Reference for the inventory include:

- selective verification of suspect data returns, and
- summarizing the reported waste data by:
  - SIC group
  - waste type
  - disposal method
  - geographic distribution

These activities are interrelated, and lend themselves to an iterative procedure of:

- initial review of individual returns to identify obvious suspect data.
- adjustment of suspect data after verification with the respondent.
- incorporation of the adjusted returns in initial data summaries.
- review of initial data summaries and comparison with previous published inventories and related studies to reveal further suspect areas.

- further adjustment of suspect data after verification with respondents and acquisition of more respondents where obvious sourcing gaps and inconsistencies existed.

- preparation of final summaries which can then be factored into waste estimates.

In the context of undertaking a direct inventory, the preceding interactive approach was used, involving some 6 major data adjustment/data summary cycles. All adjustments were based on information supplied by respondents - no data synthesis was undertaken. Such data syntheses would invalidate the direct survey, and produce a subjective mixture of reported and estimated data.

3.2 Selection of Data

In order to maximize response rates, questionnaires were designed to permit easy entry by the waste generators. It was felt that the response rate would suffer if generators had to translate their existing data into a prescribed set of units. Therefore, selection of units for reporting was at the generator's option.

Data was reported in a variety of S.I., Imperial and U.S. units for mass and volume.

Responses were then converted into a single unit for analysis. The unit selected was the metric tonne.

Conversion was relatively straight forward where responses were in units of mass or weight. For liquids, where the responses were often in units of volume, conversion involves an assessment of specific gravity or unit weight.

Since the majority of liquid streams reported were water based, a specific gravity of 1.0 was assumed for all liquid volume to mass conversions.

Conversion factors used for liquids are as follows:

1 tonne = 1 cubic metre
= 1000 litres
= 220.0 imperial gallons
= 264.2 U.S. gallons

It is recognized that specific gravities for some liquids (such as light oils) will be lower than 1.0 and for others (such as metal-bearing sludges) will be higher. However, it would be impossible to accurately assess specific gravity for every liquid waste stream reported, and it would be impractical to analyze data summaries comprised of a variety of units.

3.3 Data Analysis

To facilitate data handling and analysis, a computer file was established. A total of 741 separate records were coded and each record includes:

- company identification number

- waste type reported
- quantity (in tonnes)
- standard industrial classification number
- waste stream identification code
- present disposal method
- generation location
- present disposal location
- pre-treatment facilities
- planned increase

Using the computer data file, it was possible to carry out the numerous sorts required for the iterative data verification process, and to produce a variety of data summaries, including:

- waste reported by SIC industry group
  - 84 classifications (shown in Table 1)
- waste reported by waste category
  - 36 categories (shown in Table 2)
- waste reported by present disposal practice
  - 12 classifications (identified in Chapter 4)

- waste reported by generation location

  - identified by first 3 characters of the generator's postal code (shown in summary form in Chapter 4).

The final data summaries are presented in Chapter 4 of this report. Entry records, which identify the generators, are confidential and are not included in this document.

3.4 Verification

Data verification in a direct survey involves two basic steps:

- Identification of suspect data.
- Aquisition of better data.

Identification of suspect data is subjective by nature. It depends on the study teams' local knowledge, their judgement as to the applicability of available secondary source information, and their skills in interpreting information provided by respondents.

The identification procedure used for this inventory was as follows:

- Each individual return was initially reviewed by two senior technical staff members (a waste management specialist and an industrial chemist).

Suspect returns were flagged for follow up.

- The reviewed returns were then incorporated into data summaries which were in turn reviewed by the study team and Saskatchewan Environment staff.

  At this stage secondary source material was used to assist in flagging suspicious aggregates by waste stream and suspicious aggregates by industry group.

  The suspicious aggregates were analyzed to determine if anomalies were caused by:

  - suspect individual returns, or
  - gaps and inconsistency of sourcing.

  Suspect returns were again flagged for follow up and attempts were made to fill in any gaps in sourcing.

Acquisition of better data was carried out both by contacting additional industrial concerns and by discussing suspect data with the existing respondents.

3.5 Synthesis of Data

Throughout the data verification process a number of very relevant secondary sources were consulted, including:

"Hazardous Wastes in Northern and Western Canada" (1)
"Inventory of Waste Oil in Saskatchewan" (2)
"An Inventory of Industrial Hazardous Waste Generation in New York State" (4)

Upon completion of data verification, it was apparent that several significant anomalies existed when comparing results of this study with those of the previous studies.

Because of the anomalies, synthesis of data for certain waste streams and industrial groupings was considered.

After careful consideration it was concluded that supplemental synthesis of data was neither desirable nor practical for this inventory. The reasons are as follows:

- As previously stated, "synthesis would invalidate the direct survey and produce a subjective mixture of reported and estimated data".

- The most similar comprehensive reference document available was the "New York State" study, a recent direct survey inventory. The character of the industry groups (and consequently the number and size of waste streams within the groups) in New York was markedly different from similar groups in Saskatchewan. This could be expected when comparing a heavily populated mature industrial state with a scarcely populated young agrarian province.

  An example of the disparities between New York and Saskatchewan is shown in the following data for the industrial inorganic chemical industry (SIC 3782):

	New York	Saskatchewan
Respondents	43	3
Respondents reporting waste	30	2
Waste streams reported	113	3
Quantities reported (tonnes)	61 300	239
Waste streams/generator	3.77	1.50
Quantities/generator (tonnes)	2 040	120
Generators' employees	4 966	21

In addition to disparities resulting from the size and character of industries, the New York data is based on the American SIC classification system. The industry groupings in this system are significantly different from those in Canadian SIC system, precluding direct comparison of the majority of industries surveyed.

- The most geographically relevant reference document was the "Western Canada" study, which contains a recent indirect survey. As previously mentioned the objective of this study was not to undertake a detailed survey of wastes in the Province of Saskatchewan, but rather to develop an overall waste management strategy for Western Canada.

The "Western Canada" study states:

- "The inventory has been prepared using a theoretical approach."

- "The accuracy of the data is greatest at the general level, for example the total amount of waste in the region."

- "The data has been used in the assessment of need step of the study and will be used in the planning of regional management systems. The data are adequate for such purposes but must not be used for site specific or industry specific evaluations."

. To synthesize data requires a basic decision as to which of several sources is correct.

In using secondary source information there are always a number of uncertainties, including:

- Was the character of their generators, legislative framework and availability of disposal facilities similar?

- Did their restrictions on time and budget limit the amount of follow up?

- How co-operative were generators in supplying them with data and what level of detail was requested?

- With an overall response rate of 65 percent, a direct questionnaire approach, a survey designed specifically to match inventory objectives, and thorough follow up, it was difficult to find any merit in synthesizing data from secondary sources.

- Where anomalies exist and are of concern, the most valid approach would be to interview all suspect generators/industries. Such a level of effort is beyond the scope of this inventory, and in fact may not be warranted. Implementation of the proposed Saskatchewan manifest system will no doubt clarify some of the anomalies identified.

Discussion of anomalies between this inventory and secondary sources is presented in Chapter 4, both by industry group (section 4.2) and by waste stream (section 4.3).

4. WASTE ESTIMATES AND PROJECTIONS

4.1 Factoring Survey Data

To prepare waste estimates from survey results, it is necessary to factor reported data. Two commonly used methods are:

- By firms in industry class

  Estimated waste

  $$= \text{reported waste} \times \frac{\text{firms in SIC group}}{\text{firms reporting}}$$

- By employees in industry class

  Estimated waste

  $$= \text{reported waste} \times \frac{\text{employees in SIC group}}{\text{employees in reporting firms}}$$

The "employees" method can be utilized on either a total employees basis or production employees basis.

In order of ranking, it is generally agreed that the preferred methods of factoring are:

- By production employees in industry class
- By total employees in industry class
- By firms in industry class.

The first two methods require detailed information on employment which was not readily available for all industries surveyed in this inventory. Since employment data was available for some industries, a sensitivity analysis was

carried out to determine if waste projections by firm would vary significantly from waste projections by production employee. The results were encouraging - agreement on total wastes for the test cases was overall within 5 percent.

In view of the lack of complete employment data, and the good correlation of methods where such data was available, factoring by firms in industry class was selected for present waste estimates in this inventory. The method used was as follows:

- In general

  $$\text{Estimated waste} = \text{reported waste} \times \frac{100}{\text{response \%}}$$

- For case study service establishments (where only a 10% sample in selected municipalities was surveyed)

  $$\text{Estimated waste} = \text{reported waste} \times \frac{100}{\text{response \%}} \times \frac{100}{\text{sample \%}} \times \frac{\text{provincial population}}{\text{selected municipalities population}}$$

- For special cases (such as hospital wastes), case specific factoring methods were applied. These methods are discussed in Sections 4.2 and 4.3.

4.2 Present Waste Estimates by Industry

Based on the approach outlined in Section 4.1, present waste estimates by industry group have been prepared. These estimates and the reported data are presented in Table 5 - "Reported and Estimated Chemical Waste Quantities by SIC Group".

Reported values and estimated quantities for certain SIC groups must be considered in the following context:

- SIC 0570 - URANIUM MINES

  As previously stated, the inventory excluded mine tailings and radioactive wastes because of general incompatibility with a comprehensive waste management strategy.

  Process waste problems in uranium mining centre around control of radionuclides. The control mechanism must be carried out on-site as no off-site radioactive waste handling facility is available or planned, especially for the volumes of waste produced from a mining operation (14).

- SIC 1720 - LEATHER TANNERIES

  "Hazardous Wastes in Northern and Western Canada" (1) predicts significant amounts of tannery waste in Saskatchewan.

SIC 0010 - EXPERIMENTAL FARMS
Surveyed=6; Reporting=4; Waste Streams=15

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Herbicides	0.216	0.324
Organic solvents	3.155	4.73
Waste Oil	1.600	2.4
Oil & water	55.000	82.5
Oily sludge	20.000	30.0
Phenolic waste	.600	0.9
Acids	.600	0.9
Alkaline waste	.600	0.9
TOTAL	81.771	123.

SIC 0310 - LOGGING
Surveyed=1; Reporting=1; Waste Streams=3

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Oily sludge	18.0	18.0
Wood sugars, fibres & grit	6.8	6.8
TOTAL	24.8	24.8

SIC 0570 - URANIUM MINES
Surveyed=1; Reporting=0; Waste Streams=0

SIC 0610 - COAL MINES
Surveyed=1; Reporting=1; Waste Streams=1

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Waste Oil	235	235
TOTAL	235	235

SIC 0790 - MISCELLANEOUS NON METAL MINES
Surveyed=4; Reporting=3; Waste Streams=1

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Waste Oil	2.7	3.6
TOTAL	2.7	3.6

SIC 0794 - POTASH MINES
Surveyed=6; Reporting=6; Waste Streams=11

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
PCBs	33.568	33.6
Waste oil	780.300	780.
Oily waste	0.650	0.650
Oil and water	60.000	60.
TOTAL	874.52	875.

SIC 1090 - BEVERAGE INDUSTRIES
Surveyed=1; Reporting=1; Waste Streams=1

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Waste Oil	3.3	3.3
TOTAL	3.3	3.3

SIC 1093 - BREWERIES
Surveyed=1; Reporting=1; Waste Streams=0

SIC 1623 - TIRE AND TUBE MANUFACTURERS
Surveyed=1; Reporting=0; Waste Streams=0

SIC 1629 - MISCELLANEOUS RUBBER PRODUCTS MANUFACTURERS
Surveyed=3; Reporting=2; Waste Streams=1

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Acids	u/s	u/s

SIC 1650 - PLASTICS FABRICATING INDUSTRY, N.E.S.
Surveyed=14; Reporting=8; Waste Streams=6

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Organic solvents	2.4	4.2
Waste Oil	0.208	0.364
Plastics	26.0	46.9
TOTAL	29.408	51.5

SIC 1720 - LEATHER TANNERIES
Surveyed=3; Reporting=1; Waste Streams=0

SIC 1880 - AUTOMOBILE FABRIC ASSESSORIES INDUSTRIES
Surveyed=2; Reporting=2; Waste Streams=1

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Waste Oil	u/s	u/s

SIC 1890 - MISCELLANEOUS TEXTILE INDUSTRIES
Surveyed=4; Reporting=2; Waste Streams=0

SIC 2591 - WOOD PRESERVATION INDUSTRIES
Surveyed=6; Reporting=4; Waste Streams=3

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Waste Oil	13	19.5
Metallic wood preservatives	u/s	--
Acids	u/s	--
TOTAL	13	19.5

SIC 2593 - MISCELLANEOUS WOOD INDUSTRIES
Surveyed=1; Reporting=1; Waste Streams=3

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Waste Oil	23.5	23.5
TOTAL	23.5	23.5

SIC 2610 - HOUSEHOLD FURNITURE MANUFACTURERS
Surveyed=4; Reporting=3; Waste Streams=2

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Organic solvents	2.400	.036
Waste Oil	0.027	3.2
TOTAL	2.427	3.24

SIC 2710 - PULP AND PAPER MILLS
Surveyed=2; Reporting=1; Waste Streams=0

SIC 2860 - COMMERCIAL PRINTING
Surveyed=34; Reporting=19; Waste Streams=33

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Organic solvents	2.740	2.74
Waste oil	0.550	.984
Photochemicals	15.587	27.9
Ammonia (etc) waste	0.210	0.376
Paint/ink sludge	2.140	3.83
TOTAL	20.018	35.8

SIC 2890 - PUBLISHING AND PRINTING
Surveyed=48; Reporting=33; Waste Streams=37

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Organic solvents	0.625	0.909
Photochemicals	11.462	16.7
Oil and water	0.108	0.157
Ink/paint sludge	0.775	1.13
TOTAL	12.970	18.9

SIC 2920 - STEEL PIPE AND TUBE MILLS
Surveyed=1; Reporting=1; Waste Streams=3

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Organic solvents	108.00	108.00
PCBs	u/s	---
Scrubber dust	3000.00	3000.00
TOTAL	3108.00	3108.00

SIC 2940 - IRON FOUNDRIES
Surveyed=3; Reporting=1; Waste Streams=0

SIC 2980 - METAL ROLLING, CASTING AND EXTRUDING, N.E.S.
Surveyed=1; Reporting=0; Waste Streams=0

SIC 3010 - BOILER AND PLATE WORKS
Surveyed=2; Reporting=2; Waste Streams=1

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Waste Oil	0.041	0.041
TOTAL	0.041	0.041

SIC 3020 - FABRICATED STRUCTURAL METAL INDUSTRY
Surveyed=10; Reporting=7; Waste Streams=2

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Waste Oil	0.225	0.321
Paint residue	1.000	1.43
TOTAL	1.255	1.75

SIC 3030 - ORNAMENTAL AND ARCHITECTURAL METAL INDUSTRY
Surveyed=3; Reporting=2; Waste Streams=0

SIC 3031 - METAL DOOR AND WINDOW MANUFACTURERS
Surveyed=14; Reporting=13; Waste Streams=0

SIC 3039 - ORNAMENTAL AND ARCHITECTURAL METAL INDUSTRY, N.E.S.
Surveyed=8; Reporting=4; Waste Streams=0

SIC 3040 - METAL STAMPING, PRESSING AND COATING INDUSTRY
Surveyed=1; Reporting=1; Waste Streams=1

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Waste Oil	18.0	18.0
TOTAL	18.0	18.0

SIC 3041 - METAL COATING INDUSTRY
Surveyed=4; Reporting=3; Waste Streams=1

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Acid	0.018	0.024
TOTAL	0.018	0.024

SIC 3042 - METAL STAMPING AND PRESSING INDUSTRY
Surveyed=9; Reporting=8; Waste Streams=2

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Waste oil	0.540	0.608
Photochemicals	0.200	0.225
TOTAL	0.740	0.833

u/s - Unspecified.

TICS FABRICATING INDUSTRY, .
porting=8; Waste Streams=6

Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
2.4	4.2
0.208	0.364
26.0	46.9
29.408	51.5

ER TANNERIES
rting=1; Waste Streams=0

OBILE FABRIC ASSESSORIES
TRIES
rting=2; Waste Streams=1

Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
u/s	u/s

LANEOUS TEXTILE INDUSTRIES
rting=2; Waste Streams=0

PRESERVATION INDUSTRIES
rting=4; Waste Streams=3

Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
13	19.5
u/s	--
u/s	--
13	19.5

LANEOUS WOOD INDUSTRIES
ting=1; Waste Streams=3

Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
23.5	23.5
23.5	23.5

OLD FURNITURE MANUFACTURERS
ting=3; Waste Streams=2

Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
2.400	.036
0.027	3.2
2.427	3.24

ND PAPER MILLS
ing=1; Waste Streams=0

IAL PRINTING
ting=19; Waste Streams=33

Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
2.740	2.74
0.550	.984
15.587	27.9
e 0.210	0.376
2.140	3.83
20.018	35.8

ING AND PRINTING
ting=33; Waste Streams=37

Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
0.625	0.909
11.462	16.7
0.108	0.157
0.775	1.13
12.970	18.9

SIC 2920 - STEEL PIPE AND TUBE MILLS
Surveyed=1; Reporting=1; Waste Streams=3

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Organic solvents	108.00	108.00
PCBs	u/s	---
Scrubber dust	3000.00	3000.00
TOTAL	3108.00	3108.00

SIC 2940 - IRON FOUNDRIES
Surveyed=3; Reporting=1; Waste Streams=0

SIC 2980 - METAL ROLLING, CASTING AND EXTRUDING, N.E.S.
Surveyed=1; Reporting=0; Waste Streams=0

SIC 3010 - BOILER AND PLATE WORKS
Surveyed=2; Reporting=2; Waste Streams=1

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Waste Oil	0.041	0.041
TOTAL	0.041	0.041

SIC 3020 - FABRICATED STRUCTURAL METAL INDUSTRY
Surveyed=10; Reporting=7; Waste Streams=2

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Waste Oil	0.225	0.321
Paint residue	1.000	1.43
TOTAL	1.255	1.75

SIC 3030 - ORNAMENTAL AND ARCHITECTURAL METAL INDUSTRY
Surveyed=3; Reporting=2; Waste Streams=0

SIC 3031 - METAL DOOR AND WINDOW MANUFACTURERS
Surveyed=14; Reporting=13; Waste Streams=0

SIC 3039 - ORNAMENTAL AND ARCHITECTURAL METAL INDUSTRY, N.E.S.
Surveyed=8; Reporting=4; Waste Streams=0

SIC 3040 - METAL STAMPING, PRESSING AND COATING INDUSTRY
Surveyed=1; Reporting=1; Waste Streams=1

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Waste Oil	18.0	18.0
TOTAL	18.0	18.0

SIC 3041 - METAL COATING INDUSTRY
Surveyed=4; Reporting=3; Waste Streams=1

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Acid	0.018	0.024
TOTAL	0.018	0.024

SIC 3042 - METAL STAMPING AND PRESSING INDUSTRY
Surveyed=9; Reporting=8; Waste Streams=2

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Waste oil	0.540	0.608
Photochemicals	0.200	0.225
TOTAL	0.740	0.833

u/s - Unspecified.

SIC 3070 - HEATING EQUIPMENT MANUFACTURERS
Surveyed=3; Reporting=1; Waste Streams=1

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Organic solvents	0.005	0.015
TOTAL	0.005	0.015

SIC 3080 - MACHINE SHOPS
Surveyed=36; Reporting=18; Waste Streams=30

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Organic solvents	6.270	27.9
Waste oil	21.539	95.7
Contaminated soil	18.200	80.9
Oil and water	53.500	238.
Hydrocarbon condensate	1.925	8.56
Oily sludge	14.900	66.2
Spent caustic	16.245	72.2
TOTAL	132.58	589.

SIC 3090 - MISCELLANEOUS METAL FABRICATING INDUSTRIES
Surveyed=15; Reporting=12; Waste Streams=3

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Waste oil	0.430	0.538
Metal cleaners	48.0	60.0
TOTAL	48.430	60.6

SIC 3110 AGRICULTURAL IMPLEMENTS
Surveyed=30; Reporting=22; Waste Streams=13

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Organic Solvents	7.040	9.6
Waste oil	27.975	38.1
Oily sludge	16.200	22.1
Paint/ink sludge	5.000	6.32
TOTAL	56.215	76.7

SIC 3150 - MISCELLANEOUS MACHINERY AND EQUIPMENT MANUFACTURERS
Surveyed=24; Reporting=16; Waste Streams=12

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Organic Solvents	1.100	1.65
Pickle liquor	11.000	16.5
Waste oil	4.631	6.95
Oily sludge	4.300	6.45
Paint/ink sludge	4.770	7.16
TOTAL	25.801	38.7

SIC 3180 - OFFICE AND STORE MACHINERY MANUFACTURERS
Surveyed=1; Reporting=1; Waste Streams=1

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Waste Oil	0.27	0.27
TOTAL	0.27	0.27

SIC 3240 - TRUCK BODY AND TRAILER MANUFACTURERS
Surveyed=7; Reporting=4; Waste Streams=4

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Waste oil	1.600	2.8
Oily sludge	2.000	3.5
Paint/ink sludge	2.400	4.2
Paint residue	4.700	8.23
TOTAL	10.700	18.8

SIC 3241 - TRUCK BODY MANUFACTURERS
Surveyed=1; Reporting=0; Waste Streams=0

SIC 3242 - NON COMMERCIAL TRAILER MANUFACTURERS
Surveyed=2; Reporting=2; Waste Streams=1

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Paint/ink sludge	1.1	1.1
TOTAL	1.1	1.1

SIC 3243 - COMMERCIAL TRAILER MANUFACTURERS
Surveyed=2; Reporting=2; Waste Streams=1

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Waste oil	5.4	5.4
TOTAL	5.4	5.4

SIC 3250 - MOTOR VEHICLE PARTS AND ACCESS MANUFACTURERS
Surveyed=10; Reporting=6; Waste Streams=5

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Waste oil	2.0	3.33
Oil and water	0.8	1.33
Oily sludge	1.1	1.83
Spent caustic	134.4	224.
TOTAL	138.3	231.

SIC 3280 - BOATBUILDING AND REPAIR
Surveyed=1; Reporting=0; Waste Streams=0

SIC 3290 - MISCELLANEOUS VEHICLE MANUFACTURERS
Surveyed=1; Reporting=1; Waste Streams=0

SIC 3350 - COMMUNICATIONS EQUIPMENT MANUFACTURERS
Surveyed=4; Reporting=3; Waste Streams=8

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Pesticide	0.022	0.29
Chlorinated solvent	10.4	13.9
Organic solvents	0.540	0.72
Waste oil	0.270	0.36
Vegetable oil	1.6	2.13
Fats	2.8	3.73
TOTAL	15.632	20.8

SIC 3360 - MANUFACTURERS OF ELECTRICAL INDUSTRIAL EQUIPMENT
Surveyed=1; Reporting=1; Waste Streams=3

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
PCB	54.0	54.
Waste oil	108.0	108.
Metal cleaners	1.35	1.35
TOTAL	163.35	163.

SIC 3380 - MANUFACTURERS OF ELECTRIC WIRE AND CABLE
Surveyed=1; Reporting=1; Waste Streams=3

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Waste oil	3.6	8.6
Oil and water	2.7	2.7
TOTAL	11.3	11.3

SIC 3520 - CEMENT MANUFACTURERS
Surveyed=5; Reporting=4; Waste Streams=3

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
PCB	6.4	8.0
Waste oil	4.1	5.13
TOTAL	10.5	13.1

SIC 3560 - GLASS AND GLASS PRODUCTS MANUFACTURERS
Surveyed=1; Reporting=0; Waste Streams=0

SIC 3590 - MISCELLANEOUS NON-METALLIC MINERAL PRODUCT INDUSTRIES, N.E.S.
Surveyed=1; Reporting=0; Waste Streams=0

SIC 3591 - REFRACTORIES MANUFACTURERS
Surveyed=1; Reporting=1; Waste Streams=1

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Waste oil	0.87	0.87
TOTAL	0.87	0.87

SIC 3651 - PETROLEUM REFINERY
Surveyed=3; Reporting=2; Waste Streams=7

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Waste oil	2.2	3.3
Crude tank bottoms	10.0	15.
Hydrocarbon condensate	22.0	33.
Spent catalyst	160.0	240.
Spent caustic	2400.0	3600.
Amine waste	2.7	4.05
Lime sludge	3500.0	5250.
TOTAL	6096.9	9145.

SIC 3652 - MANUFACTURERS OF LUBRICATING OILS AND GREASES
Surveyed=4; Reporting=1; Waste Streams=1

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Oily sludge	100	400
TOTAL	100	400

SIC 3690 - MISCELLANEOUS PETROLEUM AND COAL PRODUCTS INDUSTRIES
Surveyed=8; Reporting=5; Waste Streams=6

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Waste oil	1000.1	1600.
Asphalt emulsion	1.575	2.52
Oil and water	20.225	32.4
Hydrocarbon condensate	0.5	0.8
TOTAL	1022.4	1636.

SIC 3720 - MANUFACTURERS OF MIXED FERTILIZERS
Surveyed=1; Reporting=0; Waste Streams=0

SIC 3750 - PAINT AND VARNISH MANUFACTURERS
Surveyed=1; Reporting=1; Waste Streams=1

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Organic solvents	4.9	4.9
TOTAL	4.9	4.9

SIC 3780 - MANUFACTURERS OF INDUSTRIAL CHEMICALS
Surveyed=2; Reporting=2; Waste Streams=1

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Waste oil	3.7	3.7
TOTAL	3.7	3.7

SIC 3782 - MANUFACTURERS OF INDUSTRIAL CHEMICALS (INORGANIC), N.E.S.
Surveyed=9; Reporting=3; Waste Streams=3

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Waste oil	8.6	14.3
Acids	u/s	--
Lime sludge	230.0	383.
TOTAL	238.6	398.

SIC 3783 - MANUFACTURERS OF INDUSTRIAL CHEMICALS (ORGANIC) N.E.S.
Surveyed=6; Reporting=3; Waste Streams=8

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Waste oil	2.4	4.8
Metal sludge	4.5	9.
Oily sludge	12.0	24.
Fats	432.5	865.
TOTAL	451.40	903.

SIC 3790 - MISCELLANEOUS CHEMICAL INDUSTRIES
Surveyed=4; Reporting=4; Waste Streams=5

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Pesticide	12.0	12.
Organic solvents	0.8	0.8
Waste oil	14.7	14.7
Oily sludge	32.0	32.
TOTAL	59.5	59.5

SIC 3799 - MISCELLANEOUS CHEMICAL INDUSTRIES, N.E.S.
Surveyed=12; Reporting=6; Waste Streams=3

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Pesticide	2.5	5.0
Acid	0.034	0.068
TOTAL	2.534	5.07

SIC 3911 - INSTRUMENT AND RELATED PRODUCTS MANUFACTURERS
Surveyed=2; Reporting=2; Waste Streams=1

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Chlorinated solvent	4.5	4.5
TOTAL	4.5	4.5

SIC 3913 - ORTHOPAEDIC AND SURGICAL APPLIANCES MANUFACTURERS
Surveyed=1; Reporting=1; Waste Streams=0

SIC 3930 - SPORTING GOODS AND TOY INDUSTRIES
Surveyed=1; Reporting=1; Waste Streams=0

SIC 3931 - SPORTING GOODS MANUFACTURERS
Surveyed=1; Reporting=0; Waste Streams=0

SIC 3995 - STAMP AND STENCIL (RUBBER AND METAL) MANUFACTURERS
Surveyed=1; Reporting=0; Waste Streams=0

SIC 5010 - AIR TRANSPORT
Surveyed=5; Reporting=4; Waste Streams=8

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
PCB	0.002	0.003
Organic solvents	1.55	1.94
Waste oil	4.1	5.13
TOTAL	5.652	7.07

SIC 5030 - RAILWAY TRANSPORT
Surveyed=6; Reporting=4; Waste Streams=6

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Waste oil	36.0	54.0
Oily sludge	2.3	3.45
Plastics	0.5	0.75
Spent caustic	7.0	10.5
Amine waste	10.0	15.0
TOTAL	55.8	83.7

SIC 5090 - URBAN TRANSIT SYSTEMS
Surveyed=3; Reporting=3; Waste Streams=8

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Organic solvents	2.5	2.5
Waste oil	32.1	32.1
Oily sludge	10.0	10.0
TOTAL	44.6	44.6

SIC 5430 - RADIO AND TELEVISION BROADCASTING
Surveyed=1; Reporting=1; Waste Streams=0

SIC 5720 and 5740 - ELECTRIC POWER & GAS DISTRIBUTION
Surveyed=1; Reporting=1; Waste Streams=43

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Asbestos	4.0	4.
Organic solvents	15.0	15.
Waste oil	401.80	401.8
Spent caustic	129.03	129.
Metal cleaner	1400.0	1400.
TOTAL	1949.8	1950.

SIC 5790 - OTHER UTILITIES
Surveyed=1; Reported=0; Waste Streams=0

SIC 6230 - WHOLESALERS OF MACHINERY AND EQUIPMENT, N.E.S.
Surveyed=25; Reporting=19; Waste Streams=7

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Organic solvents	0.150	0.197
Waste oil	7.443	9.79
TOTAL	7.593	9.99

SIC 6580 - MOTOR VEHICLE REPAIR SHOPS
Surveyed=17; Reporting=4; Waste Streams=6

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Organic solvents	1.070	47.3
Waste oil	1.100	48.7
Paint/ink sludge	0.670	29.6
TOTAL	2.840	126.

SIC 8050 - POST SECONDARY NON-UNIVERSITY EDUCATIONAL INSTITUTIONS
Surveyed=4; Reporting=2; Waste Streams=0

SIC 8060 - UNIVERSITIES AND COLLEGES
Surveyed=2; Reporting=2; Waste Streams=3

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Organic solvents	4.5	4.5
Waste oil	1.8	1.8
Oily sludge	1.1	1.1
TOTAL	7.4	7.4

SIC 3782 - MANUFACTURERS OF INDUSTRIAL CHEMICALS (INORGANIC), N.E.S.
Surveyed=9; Reporting=3; Waste Streams=3

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Waste oil	8.6	14.3
Acids	u/s	--
Lime sludge	230.0	383.
TOTAL	238.6	398.

SIC 3783 - MANUFACTURERS OF INDUSTRIAL CHEMICALS (ORGANIC) N.E.S.
Surveyed=6; Reporting=3; Waste Streams=8

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Waste oil	2.4	4.8
Metal sludge	4.5	9.
Oily sludge	12.0	24.
Fats	432.5	865.
TOTAL	451.40	903.

SIC 3790 - MISCELLANEOUS CHEMICAL INDUSTRIES
Surveyed=4; Reporting=4; Waste Streams=5

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Pesticide	12.0	12.
Organic solvents	0.8	0.8
Waste oil	14.7	14.7
Oily sludge	32.0	32.
TOTAL	59.5	59.5

SIC 3799 - MISCELLANEOUS CHEMICAL INDUSTRIES, N.E.S.
Surveyed=12; Reporting=6; Waste Streams=3

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Pesticide	2.5	5.0
Acid	0.034	0.068
TOTAL	2.534	5.07

SIC 3911 - INSTRUMENT AND RELATED PRODUCTS MANUFACTURERS
Surveyed=2; Reporting=2; Waste Streams=1

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Chlorinated solvent	4.5	4.5
TOTAL	4.5	4.5

SIC 3913 - ORTHOPAEDIC AND SURGICAL APPLIANCES MANUFACTURERS
Surveyed=1; Reporting=1; Waste Streams=0

SIC 3930 - SPORTING GOODS AND TOY INDUSTRIES
Surveyed=1; Reporting=1; Waste Streams=0

SIC 3931 - SPORTING GOODS MANUFACTURERS
Surveyed=1; Reporting=0; Waste Streams=0

SIC 3995 - STAMP AND STENCIL (RUBBER AND METAL) MANUFACTURERS
Surveyed=1; Reporting=0; Waste Streams=0

SIC 5010 - AIR TRANSPORT
Surveyed=5; Reporting=4; Waste Streams=8

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
PCB	0.002	0.003
Organic solvents	1.55	1.94
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TOTAL	5.652	7.07

SIC 5030 - RAILWAY TRANSPORT
Surveyed=6; Reporting=4; Waste Streams=6

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Waste oil	36.0	54.0
Oily sludge	2.3	3.45
Plastics	0.5	0.75
Spent caustic	7.0	10.5
Amine waste	10.0	15.0
TOTAL	55.8	83.7

SIC 5090 - URBAN TRANSIT SYSTEMS
Surveyed=3; Reporting=3; Waste Streams=8

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Organic solvents	2.5	2.5
Waste oil	32.1	32.1
Oily sludge	10.0	10.0
TOTAL	44.6	44.6

SIC 5430 - RADIO AND TELEVISION BROADCASTING
Surveyed=1; Reporting=1; Waste Streams=0

SIC 5720 and 5740 - ELECTRIC POWER & GAS DISTRIBUTION
Surveyed=1; Reporting=1; Waste Streams=43

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Asbestos	4.0	4.
Organic solvents	15.0	15.
Waste oil	401.80	401.8
Spent caustic	129.03	129.
Metal cleaner	1400.0	1400.
TOTAL	1949.8	1950.

SIC 5790 - OTHER UTILITIES
Surveyed=1; Reported=0; Waste Streams=0

SIC 6230 - WHOLESALERS OF MACHINERY AND EQUIPMENT, N.E.S.
Surveyed=25; Reporting=19; Waste Streams=7

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Organic solvents	0.150	0.197
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TOTAL	7.593	9.99

SIC 6580 - MOTOR VEHICLE REPAIR SHOPS
Surveyed=17; Reporting=4; Waste Streams=6

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Organic solvents	1.070	47.3
Waste oil	1.100	48.7
Paint/ink sludge	0.670	29.6
TOTAL	2.840	126.

SIC 8050 - POST SECONDARY NON-UNIVERSITY EDUCATIONAL INSTITUTIONS
Surveyed=4; Reporting=2; Waste Streams=0

SIC 8060 - UNIVERSITIES AND COLLEGES
Surveyed=2; Reporting=2; Waste Streams=3

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Organic solvents	4.5	4.5
Waste oil	1.8	1.8
Oily sludge	1.1	1.1
TOTAL	7.4	7.4

SIC 8210 - HOSPITALS
Surveyed=2; Reporting=2; Waste Streams=5

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Organic solvents	0.270	25.5
Metal sludge	0.004	0.378
Hospital wastes	1.000	88.5
Acids	0.600	56.6
TOTAL	1.874	172.

SIC 8740 - CLEANERS
Surveyed=8; Reporting=4; Waste Streams=3

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Organic solvents		80.
Waste oil	0.450	0.45
Oil and water	200.0	200.
TOTAL	200.450	281.

SIC 8910 - LABOUR ORGANIZATIONS AND TRADE ASSOCIATIONS
Surveyed=1; Reporting=1; Waste Streams=0

SIC 8930 - PHOTOGRAPHIC SERVICES, N.E.S.
Surveyed=4; Reporting=0; Waste Streams=0

SIC 9020 - DEFENCE SERVICES
Surveyed=2; Reporting=2; Waste Streams=24

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
PCB's	3.23	3.23
Organic solvents	2.565	2.57
Waste oil	119.5	120.
Photochemicals	0.315	0.315
Oil and water	25.4	25.4
Oily sludge	5.14	5.14
Lime sludge	1090.0	1090.
Solid Waste	.006	.006
Slop Oil	3.4	3.4
Metal cleaners	.06	0.06
TOTAL	1250.	1250.

SIC 9310 - PROVINCIAL ADMINISTRATION
Surveyed=1; Reporting=1; Waste Streams=1

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Asphalt emulsion	4.7	4.7
TOTAL	4.7	4.7

SIC 9510 - LOCAL ADMINISTRATION
Surveyed=13; Reporting=7; Waste Streams=11

Waste Type	Rep. Qty. Tonnes/yr	Est. Qty. Tonnes/yr
Organic solvents	1.555	2.89
Waste oil	44.99	83.65
Hydrocarbon Condensate	0.540	1.003
Oily sludge	6.0	11.14
TOTAL	53.085	98.6

TABLE 5

REPORTED AND ESTIMATED CHEMICAL AND INDUSTRIAL WASTE BY SIC GROUP

Discussion with industry sources during this study indicates that hide processing in Saskatchewan consists only of grading and preserving fresh hides with salt prior to export, and that no actual tanning is done in the province. The wastes produced are mostly hide trimmings and hide exudate, similar to some abattoir wastes.

Such wastes are not considered to be "chemical wastes" or "hazardous wastes".

The anomaly between this study and the previous study is probably due to the inclusion of hide processors in the tanners classification group.

SIC 2591 - WOOD PRESERVATION INDUSTRIES

Wood preservation industries reported quantities of waste oil and indicated wood preservative and acid wastes streams. They did not specify the quantities of the latter two streams, despite follow-up enquiries.

With respect to wood preserving wastes, U.S. experience (12) is as follows:

- Creosote or pentachlorophenol (PCP) treatment produces contaminated wastewater. This wastewater is normally treated to produce a sludge. Sludge production rates of about 0.4 tonnes/month/facility are commonly reported.

- Inorganic salt treatment does not normally produce contaminated wastewater.

- All wood preserving plants produce tank cleaning wastes, consisting of sawdust, wood chips and chemical-containing sludge. Again, from U.S. experience, typical tank clean-out residue is 0.25 tonnes/month/facility. (Note that many wood preservers operate only in spring and summer.) Landfilling (secure and otherwise) and incineration are common disposal practices.

Better data on wood preserving wastes should come available when a manifest system is implemented.

SIC 3041 - METAL COATING INDUSTRY

No cyanide wastes were formally reported.

Telephone follow-up revealed only a few small plating operations, generally spot-plating. Total plating solution use was informally reported to be less than 100 L/y. Most items to be plated were reported to be sent out of the province. Some firms stated that they intended to begin plating in Saskatchewan, but did not provide either production or waste volume estimates. An increase in cyanide wastes may therefore be expected in the future.

- SIC 3080 - MACHINE SHOPS

The number of machine shops in the province is roughly estimated at 80. The number surveyed was 36 and the number reporting 18. The wastes reported by the 18 respondents has been extrapolated to yield total estimated wastes for the entire group of 80.

- SIC 6580 - MOTOR VEHICLE REPAIR SHOPS

This SIC group includes autobody shops and wheel alignment shops. It does not include service stations or lubrication shops.

The estimated number of listings in this group is 177. The number surveyed was 17 and the number reporting 4. Wastes from those reporting were extrapolated to a total listing of 177.

On the basis of previous investigations, service station wastes were excluded from the mainstream of the study. They are discussed separately in Appendix III.

- SIC 8210 - HOSPITALS

Hospitals were dealt with as a special case. For purposes of this inventory, wastes from hospitals are defined as covering two classes of materials; as follows:

- laboratory (chemical) wastes

- hospital (pathological/infectious/anatomical) wastes

Laboratory (chemical) waste estimates were carried out as follows:

- Saskatchewan Health (16) provided data on "units of work" in the province's hospitals.

  It should be noted that the "units of work" per bed or per admission vary substantially with hospital size - larger facilities (with major lab facilities) have substantially higher ratios compared to small hospitals.

- A production rate of 1 gram of lab waste per "unit of work" was applied to the 81.6×10^6 units of work reported. This rate was considered reasonable by Saskatchewan Health.

- The resulting laboratory waste estimate was 81.6 tonnes/year.

Hospital (Pathological/infectious/anatomical) waste estimates were carried out as follows:

- Waste data was obtained for four large hospitals in Regina and size distribution data was obtained for remaining hospitals in the province.

Based on the data obtained, it became apparent that different generation rates apply depending on the size of hospitals -- the largest hospitals in Saskatoon and Regina do most of the surgery and medical-legal autopsies, other Regina and Saskatoon hospitals and regional hospitals with less than 50 beds do little surgery.

- As a conservative approach, the following waste generation rates were assumed:

    - 2.0 kg/bed/week for Regina General and Saskatoon University Hospitals

    - 0.2 kg/bed/week for remaining hospitals

  The latter figure is typical of data from the Plains Health Centre.

- The resulting pathological waste estimate was 87.5 tonnes/year.

In addition to the above, two departments of Saskatchewan Health were consulted in order to obtain data on hospital (pathological/infectious/anatomical) and laboratory waste. One questionnaire was returned with data reported for provincial health labs. This data is shown in Table 5 as reported, and consists of organic solvents, metal sludges and acids

from provincial labs as well as 1 tonne/year of "hospital" (pathological/ infectious/anatomical) wastes. This data is not extrapolated in estimated wastes projections but is added "as is" to projections for Saskatchewan hospitals discussed previously. The estimated "hospital" wastes for the Province are then 88.5 tonnes/year. The estimated lab wastes for hospitals discussed previously were distributed as organic solvents, metal sludges and acids in the same proportion as reported for provincial health labs.

SIC 8740 - CLEANERS

A 10% sample of businesses located in Regina, Saskatoon and Moose Jaw was used for this category.

While a 50% response rate was achieved, only one respondent reported wastes. The three waste streams reported by this respondent fell into the categories of "waste oil" and "oil and water" - wastes directly related to a cleaning service for industrial wiping cloths.

No waste solvents were reported, an obvious anomaly, since the most problematical waste generated in dry-cleaning arises from the processing for recovery of dirty solvents.

Solvents generally used in dry-cleaning are perchloroethylene, petroleum solvent, and Freon^{R} 113. The wastes are distillation residues, spent

filter media/filter cleaning residue, and settling tank residues. The residues may contain 25 to 60% solvent.

U.S. experience (12) is that coin operated plants produce 0.038 tonnes/month; dry-cleaning plants produce 0.120 tonnes/month and industrial plants produce 3.600 tonnes/month. Residues are commonly disposed of to municipal trash pick-up, although some distillation residues are reprocessed to recover solvent.

Statistics Canada data from 1975 (15) showed a total of 86 dry-cleaning plants in Saskatchewan (50 unincorporated, 36 incorporated), with no breakdown by coin operated/dry-cleaning plant/industrial plant.

Assuming that half of the 86 plants were coin operated and the remainder are dry-cleaning plants, one could expect solvent residue generation of the order of 80 tonnes/year - as opposed to the zero value generated by this inventory.

Better data on cleaning solvent wastes should come available when a manifest system is implemented.

- SIC 8930 - PHOTOGRAPHIC SERVICES, N.E.S.

Wastes estimates for this category were to be based on factoring up a 10% survey sample from Saskatoon,

Regina and Moose Jaw to a provincial scale. This classification is for photo finishers.

No wastes were reported by the establishments surveyed, although considerable photo-chemical wastes were reported by SIC group 2860 - Commercial Printing.

This anomaly can probably be best explained by:

- small survey sample
- significant use of large off-premises and out-of-province plants in this competitive business.

4.3 Present Waste Estimates by Waste Stream

Based on the approach outlined in Section 4.1, present waste estimates by industry group have been prepared. These estimates and the reported data are presented in Table 6 - "Reported and Estimated Chemical and Industrial Waste Quantities by Waste Classifications".

Reported values and estimated quantities for certain waste streams must be considered in the following context:

TABLE 6
REPORTED AND ESTIMATED CHEMICAL AND INDUSTRIAL WASTE QUANTITIES BY WASTE CLASSIFICATIONS

Waste Type	Rep. Qty.	Est. Qty.
WASTE OIL	2945.7	3762.
TOTAL	2945.7	3762.
OILY WASTES	0.650	0.65
• Crude tank bottoms	10.	15.
• Asphalt emulsions	6.275	7.22
• Oil and water	417.73	642.
• Hydrocarbon condensate	24.965	43.4
• Oily sludge	245.04	635.
• Slop oil	3.4	3.4
• Waste vegetable oil	1.6	2.13
TOTAL	709.66	1349.
PLANT AND ANIMAL WASTES		
• Fats	435.3	869.
• Wood sugars, fibres & grit	6.8	6.8
TOTAL	442.1	876
ACIDS	1.252	57.6
TOTAL	1.252	57.6
PICKLE LIQUOR	11.0	16.5
TOTAL	11.0	16.5
ALKALIS	.6	.9
• Spent caustic	2686.7	4036.
• Lime sludge	4820.	6723.
• Metal cleaners	1449.41	1461.
• Amine and ammonia waste	12.91	19.4
TOTAL	8969.62	12240.
SPENT CATALYST WASTE	160.0	240.
TOTAL	160.0	240.
METAL SLUDGES	4.504	9.38
TOTAL	4.504	9.38

Waste Type	Rep. Qty.	Est. Qty.
ORGANIC SOLVENTS	167.93	352.
TOTAL	167.93	352.
CHLORINATED SOLVENTS	14.9	18.4
TOTAL	14.9	18.4
PLASTIC RESINS	27.3	47.6
TOTAL	27.3	47.6
PAINT AND PIGMENTS		
• Paint and ink sludge	16.855	53.9
• Paint residue (solid)	5.7	9.65
TOTAL	22.555	63.6
PHOTOCHEMICALS	27.564	45.1
TOTAL	27.564	45.1
WOOD PRESERVING WASTES		
• Copper cadmium arsenate	u/s	u/s
PCB's	97.2	98.8
TOTAL	97.2	98.8
PESTICIDES	14.622	17.0
TOTAL	14.622	17.0
HERBICIDES	0.206	0.324
TOTAL	0.206	0.324
PHENOLS (including pentachlorophenol)	0.60	0.9
TOTAL	0.60	0.9
SOLID WASTES, N.O.S.	.006	.006
• Contaminated soil	18.2	80.9
• Scrubber dust	3000.0	3000.0
TOTAL	3018.2	3081.
ASBESTOS	4.0	4.0
TOTAL	4.0	4.0
HOSPITAL WASTES	.5	88.5
TOTAL	.5	88.5
TOTAL	16640.	22367.

Notes:
Quantities in tonnes/year.
u/s - Unspecified.
N.O.S. - Not Otherwise Specified.

OTHER REPORTED WASTE STREAMS (See Appendix I)

Waste Type	Reported
BRINE WASTES	9067000
WATERWORKS AND SOFTENING SLUDGE	1800
AGRICULTURAL CHEMICALS	
• Chemical containers & residues	4

Waste Type	Reported
FLY ASH	790000
MERCURY-CONTAMINATED WASTE	1000000
SLAG	70000

WASTE OIL

The previous "Inventory of Waste Oil in Saskatchewan" (2) estimates the following waste oil generation in the province:

Source	Quantity (m^3/y)
Manufacturing industry	350
Primary industry	503
Total (primary and manufacturing)	853

The current inventory indicates much larger quantities but covers a broader spectrum of generators and streams.

For comparative purposes the following table has been prepared, based on current inventory returns:

Source	Reported tonnes/year	Estimated tonnes/year
Total Quantity	2756	3428
Deductions: (from the waste oil study)		
Process oil	(653)	
Transformer oil (non PCB)	(160)	
Recovery off grade (recycled)	(1000)	
Government Agencies	(169)	
Transportation Industries	(55)	
Total (primary and manufacturing)	719	894

The value of 894 tonnes compares favourably with the 853 m^3 reported in the previous study.

The closeness of agreement may be to some extent illusionary, since the industry groups surveyed do not coincide entirely. This survey included other service industries (e.g. cleaners, equipment sales) and primary industries (power generation) that were apparently not included in the previous study group. Conversely, transportation and government waste oil generators were sampled in greater depth in the previous study.

- OILY WASTES (CRUDE TANK BOTTOMS)

Respondents were generally confused about the meaning of tank bottoms. Wastes that could be classified as such were generally reported by some more specific term.

- PLANT AND ANIMAL WASTES (Fats)

Only one fatty material producer responded to the questionnaire. This large value is due to the single response.

- ACIDS

Significant inorganic acid wastes of any type were reported in only one firm, as a result of metal pickling. Minor uses in water treatment for boilers accounted for small amounts.

- ALKALIS

Producers of these wastes generally fall into three main categories:

- water treatment
- metal cleaning
- gas treatment/chemical processing

Water treatment wastes have high pH, but are generally dilute and free from other major chemical contamination. They have been excluded from the mainstream of the inventory and are discussed in Appendix I.

Metal cleaning wastes are somewhat more concentrated and tend to contain suspended solids, oils and metals; and gas treatment wastes contain more sulphur compounds. These categories predominate in the reported values for alkalis.

- CYANIDE

"Hazardous Wastes in Northern and Western Canada" (1) estimates 70 tonnes/year production of cyanide wastes in Saskatchewan.

Cyanide wastes are generated primarily in:

- electroplating
- electronic component manufacture
- gold ore processing

No cyanide wastes were formally reported in this study, but quantities may be expected from the plating industry in the future (see discussion in Section 4.2 on SIC Group 3041).

- SULPHUR

"Hazardous Wastes in Northern and Western Canada" (1) estimates 120 tonnes/year production of sulphur wastes in Saskatchewan.

No respondent reported generating waste sulphur, although it is to be expected that sulphur will be produced in some of the petroleum refining occurring in the province. If the producer considers it a product rather than a waste, it would not be reported with wastes.

- ORGANIC SOLVENTS

Estimated quantities compare well with "Western Canada" data, but reflect low levels of activity in metal parts cleaning. A growth in parts manufacture in major industrial centres would generate considerably more of such wastes than presently occurs in Saskatchewan.

- PHOTO CHEMICALS

See dicussion in Section 4.2 on SIC Group 8930.

- WOOD PRESERVING WASTES
- PHENOLS (including pentachlorophenol)

See discussion in Section 4.2 on SIC Group 2591.

- PESTICIDES

Waste data from pesticide formulators varied significantly - some reported large quantities of waste and others reported none. Because of these disparities in responses, direct follow-up was carried out and revealed:

- Wastes from formulators are generally spills, off-specification product, and equipment clean-up residues. "Housekeeping" is a critical factor.

- Some formulators dispose of off-specification batches as waste and other upgrade these batches by blending with on-specification material.

- In one case, off-specification product was sold for use on an "as-is" basis.

U.S. data (12) suggests an average of .663 tonnes/month of waste per generating establishment is normal, and that most of this material is usually landfilled (with minor amounts incinerated and recycled).

- HERBICIDES

  On-farm handling of herbicices and herbicide containers was excluded from the mainstream of the study and is discussed in Appendix I.

- HOSPITAL WASTES

  The estimated 88.5 tonnes/year of hospital (pathological/infectious/anatomical) waste differs markedly from the 930 tonnes/year estimated in the "Western Canada" study. It is not known how estimates were derived in the latter study. It is possible that the report assumed the infectious waste generation rate per bed in large urban hospitals (e.g. Regina General) applied across the province.

In summary, the following comments can be made on the waste stream estimates in Table 6.

- The estimates are based on returns from 65% of the industries and agencies surveyed. These respondents represent some 80% of the industrial employment in the industries surveyed.

  Consequently, it is believed that the estimate of present total chemical wastes in Saskatchewan forms a satisfactory basis upon which a waste management strategy can be developed.

- For specific waste categories, the estimates must be used with caution.

In addition to the anomalies mentioned earlier in this section, a large number of waste streams have been dominated by one or two contributors. A change in process by an existing generator, or introduction of new processes by a new generator could have major impacts on a specific waste stream.

4.4 Present Waste Generation by Geographic Area

Wastes reported were distributed geographically as follows:

TABLE 7
GEOGRAPHIC WASTE DISTRIBUTION

Waste Generation Area	Total Wastes Reported (tonnes/year)	Major Waste Generators	Wastes By Major Generators (tonnes/year)	Wastes Reported By Remaining Generators (tonnes/year)
Regina	10 626	2	8 900	1 726
Saskatoon	1 499	-	-	1 499
Moose Jaw	1 036	1	1 000	36
Assiniboia-Gravelbourg & Area	1 527	1	1 400	127
Rosthern-Humbolt-Watrous & Area	1 129	1	1 090	39
Estevan	342	-	-	342
remainder of province	477	-	-	477
TOTAL	16 636	5	12 390	4 246

This distribution suggests that most wastes in the Province are generated in the Regina-Moose Jaw area. If wastes generated by the 5 major generators (Table 7) are excluded, the major waste centres are Regina and Saskatoon.

Prior to contemplating the establishment or siting of any facility, further assessment must be carried out to determine which waste categories would be destined to a central facility and establish a policy for on-site treatment of chemical wastes.

4.5 Significance of Major Waste Generators

Review of reported waste streams indicates that of the 16 636 tonnes/year of wastes reported, 12 390 tonnes/year (75%) were from 5 sources. Arbitrarily, any generator reporting 1000 tonnes/yr or more at one location was considered to be a major generator. (Wastes produced at other locations by these five generators are not included in the 12 390 tonnes/year.) This situation presents the following concerns:

- Any assessments which are developed for the total estimated chemical wastes (including these major generators) will no doubt be biased to these major waste streams.

- There may be significant economic merit in pre-treating, or treating and disposing of these wastes at the generator's site.

There is clearly a need to further assess these waste streams, the disposal practices used, and the need for treating these at a centralized facility. Should some or all of these wastes be excluded from a provincial waste management strategy, then waste management options have to be re-assessed in terms of the remaining wastes.

4.6 Future Waste Projections

Three approaches were considered in estimating future waste quantities:

- projections reported in the survey questionnaire,
- projections using general economic data,
- projections using population data.

Projections reported in the survey questionnaire were uniformly non-quantitative (as opposed to reasonably detailed and precise reporting of current waste output). At most, the survey indicates cautious expansion in line with business or population growth. Only a few respondents stated explicit growth plans.

Based on the reported future increases, the following would be the additional wastes expected for 1985. No projections were reported for 1990.

TABLE 8
REPORTED WASTE INCREASES

Waste Type	1985 Additional Future Wastes tonnes/year	% increase
Waste Oil	195	6.65
Asphalt Emulsions	0.7	11.16
Oil and Water	0.1	0.02
Hydrocarbon Condensate	1.1	4.41
Oily Sludge	7.5	2.17
Waste Vegetable Oil	0.8	50.0
Pickle Liquor	4.4	40.0
Solvents	6.0	3.28
Paint Sludge	0.01	0.06
Photo Chemicals	negligible	--
TOTAL	215	**

** The weighted average increase, based on an estimated total waste generation of 22 367 tonnes/year is about 1%.

The preceding "reported" waste projections appear to be unreasonably low.

Projections using general economic data require long-term trend data, which again were not forthcoming.

In discussions with Saskatchewan Industry and Commerce, it was concluded that no reliable long-term economic projections were available.

Projections using population data were selected for waste inventory projection purposes. Long-term trend data were available, and it is believed to be reasonable to assume that changes in waste production will occur as a result of population growth, product demand and changes in industrial activity.

Two estimates of growth were reviewed:

- Statistics Canada (10) projected population until 1987, implying an annual growth rate of 1.30% to 1.35%.

- Canada Manpower (17) projected a growth rate in employment of 2.5% in the 1980's (compared to about 3.0% in the 1970's).

For study purposes, it was assumed that waste growth would follow the mean of the two preceding estimates, with a 9% cumulative increase for the period 1981 to 1985 and 19% cumulative increase for 1981-1990.

Applying these increases to the estimated waste quantities, the 1985 and 1990 waste estimates are given in Table 9.

TABLE 9

PROJECTED 1985 & 1990 CHEMICAL WASTE QUANTITIES

Waste Type	Projected Quantities 1985	1990
WASTE OIL		
TOTAL	4100. / 4100.	4477. / 4477.
OILY WASTES	0.709	0.774
• Crude tank bottoms	16.4	17.9
• Asphalt emulsions	7.87	8.60
• Oil and water	700.	764.
• Hydrocarbon condensate	47.3	51.6
• Oily sludge	692.	756.
• Slop Oil	3.71	4.05
• Waste vegetable oil	2.33	2.54
TOTAL	1470.	1605.
PLANT AND ANIMAL WASTES		
• Fats	947.	1034.
• Wood sugars fibres & grit	7.41	8.09
TOTAL	954.	1042.
ACIDS	62.8	62.8
TOTAL	62.8	62.8
PICKLE LIQUOR	18.0	19.6
TOTAL	18.0	19.6
ALKALIS	0.981	1.07
• Spent caustic	4399.	4803.
• Lime sludge	7328.	8001.
• Lime slurry	417.8	456.1
• Metal cleaners	1592.94	1739.08
• Amine and ammonia waste	21.2	23.2
TOTAL	13542.	14567.
SPENT CATALYST WASTE	262.	286.
TOTAL	262.	286.
METAL SLUDGES	10.2	11.2
TOTAL	10.2	11.2

Waste Type	Projected Quantities 1985	1990
ORGANIC SOLVENTS	383.	419.
TOTAL	383.	419.
CHLORINATED SOLVENTS	20.0	21.9
TOTAL	20.0	21.9
PLASTIC RESINS	51.9	56.7
TOTAL	51.9	56.7
PAINT AND PIGMENTS		
• Paint and ink sludge	58.7	64.1
• Paint residue (solid)	10.5	11.5
TOTAL	69.2	75.6
PHOTOCHEMICALS	49.2	53.7
TOTAL	49.2	53.7
WOOD PRESERVING WASTES		
• Copper cadmium arsenate	u/s	u/s
PCB's	108.	118.
TOTAL	108.	118.
PESTICIDES	18.6	20.3
TOTAL	18.6	20.3
HERBICIDES	0.353	0.386
TOTAL	0.353	0.386
PHENOLS (including pentachlorophenol)	.981	1.07
TOTAL	.981	1.07
SOLID WASTE, N.O.S.	.006	.007
• Contaminated soil	88.2	96.3
• Scrubber dust	3270.	3570.
TOTAL	3358.	3666.
ASBESTOS	4.36	4.76
TOTAL	4.36	4.76
HOSPITAL WASTES	96.5	105.
TOTAL	96.5	105.
TOTAL	24380.	26617.

Notes:

Quantities in tonnes/year.

u/s - Unspecified.

N.O.S. - Not Otherwise Specified.

5. TREATMENT AND DISPOSAL OPTIONS

5.1 General

The Terms of Reference for this inventory include:

- summarization of reported waste data by present disposal method
- identification of treatment/disposal options, and
- segregation of waste estimates into broad streams suitable for treatment/disposal by the available options.

The information presented in this Chapter is intended to provide a data base on which a waste management strategy may be developed. It must not be construed as an assessment of the adequacy and environmental soundness of either current practices or identified options.

5.2 Current Waste Disposal Practices

Disposal practices reported by the questionnaire respondents were:

- recovery
- reclamation
- incineration
- physical/chemical treatment
- biological treatment
- deep well disposal

- storage
- landfill
- municipal sewer
- out-of-province specialized facility
- linen service
- on-site land disposal
- surface water discharge
- lagoon

A summary of reported disposal practices for a number of waste streams is presented in Table 10.

The reported data should be viewed in the following context:

- Response Rate

  Present disposal practices were reported for 99% of the total waste quantities reported. The disposal methods used for the remaining 1% are not known.

- Recovery

  Recovery is defined as reprocessing waste for same use (recycling).

  This practice was reported for only a small percentage of waste oils and organic solvents.

- Reclamation

  Reclamation is defined as processing waste for different use.

	Recovery	Recycle	Incineration	Physical/ Chemical Treatment	Biological	Deep Well	Storage	"Secure" Landfill	Sanitary Landfill	Municipal Sewers	Out of Province Facility	Lime Service	On-Site Land Disposal	Surface Discharge	Lagoon	Not Specified	Total
WASTE OIL	1074.7	373.21	501.16				97.4		353.08	22.364			22.312		3.4	69.87	2945.7
OILY WASTE			.65														.65
- Crude Tank Bottoms													10				10
- Asphalt Emulsions									1.575				4.7				6.275
- Oil & Water	60		1.1		30				220.33	.8		.108	2.4		67	36	417.73
- Hydrocarbon Condensate			22						1.84	1.925							24.865
- Oily Sludge	1.1								131.1	0.8			86.8		1.4	16.1	249.
- Waste Vegetable Oil																1.6	1.6
- Slop Oil			.9						2.5								3.4
PLANT & ANIMAL WASTE																	0
- Fats									21.7				413.6				435.3
- Wood Pulps & Fibres	6.8																6.8
ACIDS										.6					.6	0.52	1.32
ALKALIS															.6		.6
- Spent Caustic	100					2400				137.38			11.013			38.302	2686.7
- Lime Sludge									1320				3500				4820.
- Hotel Cleaners										40.06				1400		1.38	1440.4
- Ashes & Aqueous Soils			2.7							10.105			.105				12.91
SPENT CATALYST								160									160
METAL WASTES							4.9			.004							4.904
ASBESTOS													0/S				0
DRILLING MUDS	13.0	100	6.388						19.625	6.524		.392	9.52		.6	3.76	167.93
CONTAMINATED SOILS									12.5							2.4	14.9
PLASTIC RESINS									27.3								27.3
PAINTS & PIGMENTS																	0
- Paint & Ink Sludge		9	2.4						4.002	.894		.010	4.5			.641	16.895
- Paint Residue									5.7								5.7
PHENOLICS	4.7	3.384							.713	13.443						3.315	27.564
OTHER PETROLEUM CHEMICALS	0/S																0
PCB'S							6.4				90.798				.002		97.3
PESTICIDES							2.9		12.1	.622							14.622
SOLVENTS			.69	.136													.326
OTHERS															.6		.6
SOLID WASTES, N.O.S.															.005		.005
- CONTAMINATED SOIL									10.2								10.2
- SEWAGE SLUDGE													3000				3000.
ASBESTOS									4								4
HOSPITAL WASTES			.5														.5
TOTALS	1261.	489.69	977.78	.135	30	2400	71.0	160	2163.7	261.62	90.798	.718	7095.	1400.	76.21	172.	16640.

NOTES:

Quantities in Tonnes/year.

0/S - Unspecified.

TABLE 10

PRESENT DISPOSAL PRACTICES

Fractions of several waste streams fell into this category. In particular, utilization of waste hydrocarbons for fuel, road oiling or on-site dust suppression was reported.

- Incineration

Incineration is a major disposal method for waste oils, generally in on-site incinerators or in open pits.

- Physical/Chemical Treatment

Physical and chemical treatment identified has generally been limited to pH adjustment to neutralize acidic or basic wastes, prior to disposal to sanitary sewers. Wastes so treated have been generally reported under "municipal sewers".

- Deep Well Disposal

Deep well disposal was the primary disposal option reported for spent caustics.

In addition, substantial quantities of brines are disposed of in this manner (see Appendix I).

- Storage

In-province storage by industries was only reported for metal sludges, PCB's and pesticides.

On-farm pesticide and herbicide containers also fall into this category (see Appendix I).

- Landfills

As expected, significant fractions of most waste streams were disposed of in municipal landfills.

- Municipal Sewers

Information was requested on the pre-treatment of waste prior to disposal. This information is particularly relevant for disposal to sanitary sewers. Of the 19 waste streams identified as being discharged to sanitary sewers, five are neutralized and one is lagooned.

In an effort to assess the degree of control of industrial waste discharge to sanitary sewers, 11 cities in the province were surveyed. All replied with copies of their industrial waste control by-laws. Generally, although industrial waste discharge contributed to some municipal sewage plant operational problems, there did not appear to be a pressing requirement for industrial waste pre-treatment facilities.

- Out-of-province Specialized Facilities

  Small quantities of wastes (particulary PCB's) are hauled out-of-province for specialized disposal. Kinetic Contaminants in Nisku, Alberta and Chem-Security in Arlington, Oregon were identified as receivers of Saskatchewan wastes.

- On-site Land Disposal

  This category of treatment/disposal includes on-site landfills, pits, land-spreading and spraying.

  Significant percentages of pickle liquor, contaminated soil and organic solvents are disposed of in this manner.

- Surface Discharge

  Surface discharge is considered to include discharge surface waters or drainage. One respondent reported the discharge of liquids to a lagoon "with no deliberate treatment". This has been interpreted as surface discharge and not "lagoon" treatment.

5.3 Available Treatment Technology

Before identifying in detail the specific processes required of

any centralized chemical waste treatment and disposal facility, it is important to consider the broad system options available. The options considered for a Saskatchewan chemical waste management strategy are:

- recovery/reclamation
- thermal destruction
- physical/chemical treatment
- land disposal
- specialized treatment/disposal/storage

These are exemplied as follows:

- Recovery/reclamation - either for its original use or for some other use. This has been well exemplified in the study responses, mainly regarding solvents (redistilled for re-use), and waste engine oil (re-refined for re-use as lubricant, or used for other purposes). Additionally, recovery is a beneficial way to eliminate wastes materials containing environmentally persistent or particularly problematic substances such as heavy metals or pesticides. Reclamation of some materials is potentially profitable; photochemicals are routinely processed to recover silver, and fly ash may be collected for use as a solidifying agent for chemical treatment.

- Thermal Destruction - Incineration may be used either as a destruction method or as a source of energy. Needs will differ for those materials which do not have a harmfull residue and for those whose volatile combustion products or solid residues are themselves an environmental problem; for instance, materials containing chlorinated hydrocarbons (such as certain pesticides) or heavy metals (such as certain paint residues).

  An incineration policy would have to take into consideration that incineration is only part of a chemical waste management program and that if not properly treated, residues may pose disposal problems.

- Physical/Chemical Treatment - Physical/chemical treatment includes all treatment, other than thermal, which would render the material innocuous. There are many different processes which are used for physical/chemical treatment, reflecting the diversity of wastes that are treated under this category. Perhaps the most common of "physical/chemical treatment" is concentration of the waste by settling or decanting. Other treatments include neutralization (acids and alkaline wastes); oxidation (cyanides); precipitation (metals); chelation (metals); flocculation (suspended particles); solubilization (sediments) and absorption, solidification, and so on. Physical/chemical

treatments have in common the need for substance - specific treatment processes and on-site expertise. It can also be seen that inappropriate treatment can be detrimental if the treatment enhances rather than reduces the degree of hazard, for instance, by releasing toxic gases or producing hazardous oxidation products.

Some biological treatment practices may be considered in this category.

- Land Disposal - This category includes disposal practices which have in common the disposal of wastes on land. Deep well injection, sanitary, on-site and secure landfilling, and land spraying have all been reported. The type of land disposal to be considered will depend on the persistence, degradability and environmental effects of the waste and the degree of treatment to be given the waste before disposal. Persistent toxic materials will need the most secure disposal.

- Specialized Treatment/Storage/Disposal - Where materials cannot be safely disposed of in any of these ways (PCB's are an example), secure storage or specialized disposal is required. "Specialized disposal" is often secure storage under controlled conditions.

The development of a comprehensive waste management strategy requires a combination of the preceding options since the individual options cannot always provide complete treatment and disposal of all the waste streams reported. These options are interrelated as shown in Figure 1. Implied are the following conditions and constraints:

- Each option is appropriate to specific type(s) of wastes. For some waste streams there is great flexibility in selecting alternative treatment/disposal options while for others the choices are limited.

- For thermal destruction and recovery there may be residues generated which will require disposal. The disposal of these is not addressed since:

  - in many cases, particularly for incineration, these residues are relatively innocuous and do not require unusual disposal practices

  - in other cases such as waste recovery further assessment is required to identify the specific nature and quantities of these residues.

- The design and operational standards applied to the processes for each option will impact on the need for alternate methods. For example, high standards for secure landfilling in some cases may allow the land disposal of wastes which may otherwise require incineration.

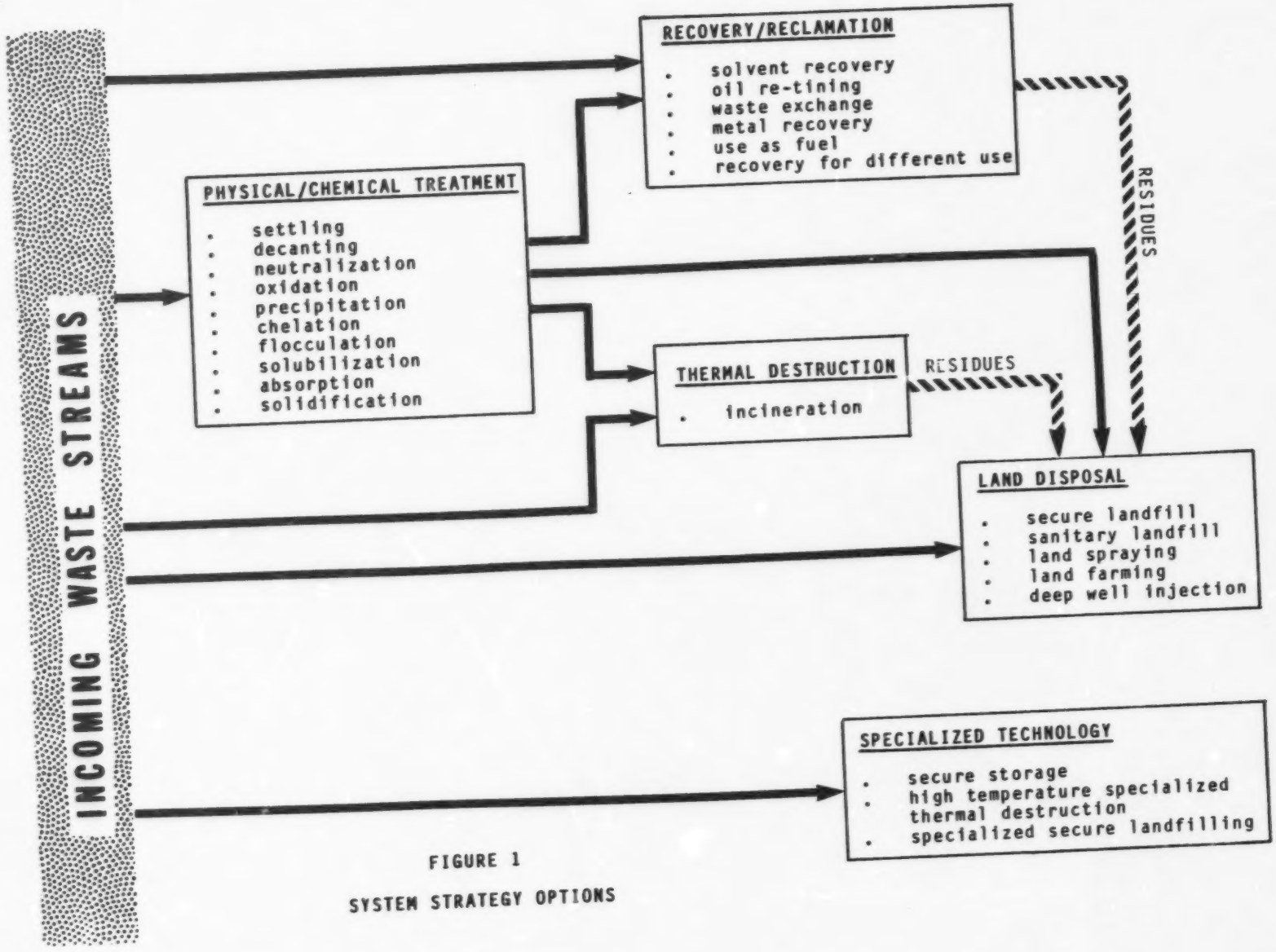

FIGURE 1

SYSTEM STRATEGY OPTIONS

- Economic trade-offs are not considered. Economics may dictate a clear preference of one option over others. In particular it may be desirable to dewater certain wastes prior to transport to a centralized facility. Therefore dewatering as a physical/chemical process at a collection facility may be required for economic reasons.

5.4 Disposal Options by Waste Classification

For each waste classification, waste management options based on those described in the previous section have been developed. The treatment/disposal of each waste classification is assessed for the following:

- recovery/reclamation
- thermal destruction
- physical/chemical treatment
  - with recovery/reclamation
  - with thermal destruction
  - with land disposal
- land disposal
- specialized treatment/disposal/storage

In considering the suitability of each of the preceding options, it is important to note that:

- **Preferred options for each waste type are identified.** Other options may be feasible under certain conditions, however further detailed assessment of the specific waste stream is required.

- **Implied waste definitions are used.** For example, although certain waste streams may be routinely recovered, in some cases their contamination with other wastes make their recovery uneconomical. Such assessments which requires a detailed waste characterization are beyond the scope of this study.

- **Projected waste classification totals given in Table 6 are used.** As discussed previously 12 390 tonnes of wastes are reported by 5 waste generators. Should acceptable solutions be developed for the treatment and disposal of these wastes, then the provincial waste management strategy for the remaining wastes needs to be assessed.

- **The acceptability and suitability of present disposal practices is not assessed.** Further assessment and legislation of present practices may permit some wastes to continue to be disposed of in the present way.

- **Current practice and trends in other jurisdictions are considered.** A conservative approach is used in identifying suitable options. Recent legislation and waste management practice in other jurisdictions in Canada and the U.S. restrict waste disposal options for certain wastes. These trends have been interpreted as an indication of possible future waste management practice in Saskatchewan.

The options suggested for each waste classification are given in Table 11.

Waste quantity projections developed in Table 6 have been applied to the waste management options matrix (Table 11). The quantities "processable" by waste classification and by total wastes generated for each option are given in Table 12.

Examination of this data yields the following observations:

- Land disposal options are applicable to 12 138 (54%) tonnes of the total waste stream. Of this 9723 tonnes are lime sludge and scrubber dust and are generated in large quantities by 3 sources. A waste management strategy premised on promoting the on-site treatment and/or disposal of these waste by industry would greatly reduce the need for centralized land disposal of chemical wastes.

- The potential for recovery is directed primarily at waste oils (3762 tonnes). There is a potential for recovery of fats (869 tonnes) reported by one source,

TABLE 11

WASTE MANAGEMENT OPTIONS MATRIX

	Recovery	Thermal Destruction	Land Disposal	Phys./Chem. & Recovery	Phys./Chem. & Thermal Destruction	Phys./Chem. & Land Disposal	Specialized Technology
WASTE OIL	X	X					
OILY WASTE			X	X	X		
- Crude Tank Bottoms	X	X	X				
- Asphalt Emulsions	X	X					
- Oil & Water			X	X	X		
- Hydrocarbon Condensate	X	X					
- Oily Sludge			X	X	X	X	
- Waste Vegetable Oil	X	X	X	X			
- Slop Oil		X	X				
PLANT & ANIMAL WASTE					X		
- Fats	X	X	X				
- Wood Sugars & Fibres			X		X		
ACIDS	X					X	
PICKLE LIQUOR	X					X	
ALKALIS						X	
- Spent Caustic			X			X	
- Lime Sludge						X	
- Metal Cleaners						X	
- Amine & Ammonia Waste							
SPENT CATALYST						X	
METAL SLUDGES			X				
ORGANIC SOLVENTS	X	X					
CHLORINATED SOLVENTS	X	X					
PLASTIC RESINS	X	X	X				
PAINTS & PIGMENTS							
- Paint & Ink Sludge		X	X				
- Paint Residue		X	X				
PHOTOCHEMICALS	X		X		X	X	
PCB'S		X					X
PESTICIDES	X	X					
HERBICIDES	X	X					
PHENOLS	X	X					
SOLID WASTES, N.O.S.			X				
- Contaminated Soil			X				
- Scrubber Dust			X				
ASBESTOS			X				
HOSPITAL WASTES		X					

TABLE 12

ESTIMATED WASTE QUANTITIES BY OPTIONS

	Totals	Recovery	Thermal Destruction	Land Disposal	Phys./Chem. & Recovery	Phys./Chem. & Thermal Destruction	Phys./Chem. & Land Disposal	Specialized Technology
WASTE OIL	3762.	3762.	3762.					
OILY WASTE	.65			.65	.65	.65		
- Crude Tank Bottoms	15.	15.	15.	15.				
- Asphalt Emulsions	7.22	7.22	7.22					
- Oil & Water	642.			642.	642.	642.		
- Hydrocarbon Condensate	43.4	43.4	43.					
- Oily Sludge	636.			636.	636.	636.	636.	
- Waste Vegetable Oil	2.13	2.13	2.13	2.13				
- Slop Oil	3.4		3.4	3.4				
PLANT & ANIMAL WASTE								
- Fats	889.	889.	860.	889.				
- Wood Sugars & Fibres	6.8			6.8		6.8		
ACIDS	57.6	57.6					57.6	
PICKLE LIQUOR	16.5	16.5					16.5	
ALKALIS	.9							
- Spent Caustic	4836.						4836.	
- Lime Sludge	6723.			6723.			6723.	
- Metal Cleaners	1461.						1461.	
- Amine & Ammonia Waste	19.4						19.4	
SPENT CATALYST	240.						240.	
METAL SLUDGES	9.38							
ORGANIC SOLVENTS	352.	352.	352.					
CHLORINATED SOLVENTS	18.4	18.4	18.4					
PLASTIC RESINS	47.7	47.7	47.7					
PAINTS & PIGMENTS								
- Paint & Ink Sludge	53.9		53.9	53.9				
- Paint Residue	9.65		9.65	9.65				
PHOTOCHEMICALS	46.1	46.1		46.1		46.1	46.1	
PCB'S	98.8		98.8					98.8
PESTICIDES	17.0	17.0	17.0					
HERBICIDES	.324	.324	.324					
PHENOLS	.9	.9	.9					
SOLID WASTES, N.O.S.	.006			.006				
- Contaminated Soil	80.9			80.9				
- Scrubber Dust	3000.			3000.				
ASBESTOS	4.			4.				
HOSPITAL WASTES	88.5		88.5					
TOTALS	22367.	5254.	5289.	12138.	1277.	1330.	13235.	98.8

NOTES:

Quantities in Tonnes/year.

N.O.S. - Not Otherwise Specified.

however further assessment is needed to confirm its feasibility.

- Many of the wastes (5179 tonnes) which may be thermally destructed also have recovery potential, thus the degree of success achieved in waste recovery and reclamation programs would establish the quantities requiring thermal destruction. Wastes which should be incinerated and cannot be normally recovered are paint and ink sludges and paint residues. Paint and inks (64 tonnes) may alternately be disposed by land disposal. As an alternative to thermal destruction PCB's (99 tonnes) may be disposed by specialized technology. Presently PCB's from Saskatachewan are transported to Alberta and Oregon for storage and/or disposal.

- The need for physical/chemical treatment is greatly dependent on the fundamental waste management concept (recovery, thermal, land disposal). It is noted however, that a relatively small fraction of wastes (approx. 1300 tonnes) may require physical/chemical treatment.

6. CONCLUSIONS & RECOMMENDATIONS

6.1 Conclusions

The following conclusions are drawn based on the assessments of this study:

- The estimated 1981 chemical waste generation rate for Saskatchewan is 22 367 tonnes/year.
- The projected 1985 chemical waste generation rate is 24 380 tonnes/year.
- The projected 1990 chemical waste generation rate is 26 617 tonnes/year.
- Five major waste generators account for 12 390 tonnes/year of the reported 16 640 tonnes/year of reported wastes.
- The SIC'S contributing significantly to waste generation are:

SIC	0794	Potash Mines	875	tonnes/year
	2920	Steel Pipe and Tube Mills	3 108	
	3651	Petroleum Refining	6 097	
	3690	Miscellaneous Petroleum and Coal Products Industries	1 022	
	5720/ 5740	Electric Power and Gas Distribution	1 950	
	9020	Defence Services	1 250	
		Total	14 302	tonnes/year

- The major waste classifications (by reported wastes) are:

Waste Oil	2 946	tonnes/year
Spent Caustic	2 687	
Lime Slurry	4 820	
Metal Cleaner	1 449	
Scrubber Dust	3 000	
Total	14 902	tonnes/year

- The geographic distribution of reported waste is:

Regina	10 626	tonnes/year
Saskatoon	1 499	
Moose Jaw	1 036	
remainder of province	3 476	
Total	16 636	tonnes/year

- Excluding major waste generators (over 1000 tonnes/year) the geographic distribution of reported waste is:

Regina	1 726	tonnes/year
Saskatoon	1 499	
Moose Jaw	36	
remainder of province	985	
Total	4 246	tonnes/year

- Discrepancies with the Western Canada Study (1) are attributed primarily to the fundamental differences in survey approaches taken in this study (direct survey) vs. that taken in the Western Canada Study (indirect survey).

- **Present reported disposal practices include:**

Recovery	1 261	tonnes/year
Reclamation	490	
Incineration	918	
Deep Well Disposal	2 400	
Sanitary Landfill	2 164	
On-site Land Disposal	7 095	
Surface Discharge	1 400	
Total	15 728	tonnes/year

- **The treatment/disposal options** available and the estimated (1981) waste quantities "processable" for each are:

Physical/Chemical Treatment & Land Disposal	13 235	tonnes/year
Land Disposal	12 138	
Thermal Destruction	5 389	
Recovery/Reclamation	5 254	
Physical/Chemical Treatment & Thermal Destruction	1 330	
Physical/Chemical Treatment & Recovery/ Reclamation	1 277	
Specialized Technology	99	

6.2 Recommendations

Based on the study conclusions and discussions of previous sections, the following recommendations are made:

- The adequacy and environmental soundness of current waste disposal practices should be further assessed prior to the development of an overall chemical waste management strategy.

- Wastes requiring a centralized treatment facility should be identified through legislation and waste definition.

- Waste quantities and practices of major waste generators should be further evaluated since they significantly impact on the province's waste management strategy.

- The feasibility of treating and disposing or pre-treating wastes on-site by the generators should be assessed before including them in the planning of any centralized treatment/disposal facility.

- Further refinement of the data presented in this study should be made by implementation of a chemical waste manifest system.

- The location and nature of any centralized treatment/disposal facility and secondary pre-treatment/collection facilities should be assessed after consideration of:

    - environmental impacts of present treatment/disposal practices

    - waste types and quantities requiring these facilities

    - role of industry in treating and disposing their own wastes

    - the promotion and assessment of effectiveness of waste recovery programs.

- The need for thermal destruction facilities should be assessed based on the effectiveness of recovery programs since the majority of recoverable wastes have thermal destruction as an alternate option.

- Land disposal should be provided for innocuous and treated wastes and waste residues. The standards for operation, design, and security of these facilities must be defined in terms of the wastes to be disposed of.

- The use of specialized facilities for the disposal of PCB's must be addressed and incorporated into any overall waste management strategy.

- Physical/chemical treatment of a portion of the waste stream should be provided. The extent of this treatment will depend on whether a provincial system is based primarily on land disposal, thermal destruction, or recovery/reclamation.

M. M. DILLON LIMITED

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APPENDIX I

OTHER WASTE STREAMS

APPENDIX I
OTHER WASTE STREAMS

Several important classes of waste merit separate discussion because their extremely large quantities or their widely spread distribution do not make them amenable to disposal or treatment in an overall waste management system.

Quantity data, as provided by survey respondents on a number of these streams, and is shown under "Other Reported Waste Streams" at the bottom of Table 6. However, these reported quantities were not included in any of the overall quantity estimates.

1. BRINES

These have been accorded discussion in this report not because of their hazardous properties, but because of the logistic problems intrinsic in handling the large volumes involved. Brine wastes are generated in the production of salt and potash. Some reported quantities and treatment methods are:

Company	Mass (tonnes/year)	Disposal
A	63 000	Discharge to lagoon
B	10 000	Disposal well
C	3 200	Disposal well and tailings pile
D	1 640	Tailings pile and brine pond
E	1 000 000	Tailings pile
	6 000 000	Deep well injection
F	recycled on site	

(To maintain anonymity, company names have been coded.)

Disposal of small quantities of these materials would present no problem. However, in the volumes produced, any land disposal technique would result in significant salt contamination. Any physical or chemical treatment would not, even if practical, decrease the volume to be stored or disposed of to a manageable level. Because of the volumes involved, transportation of brine wastes to a distant disposal site is prohibitively expensive. For sheer logistic reasons, there can be no question that waste handling and disposal must be closely associated with the producer plant.

Disposal methods currently in use are surface disposal techniques such as lagoons and tailings piles, or subsurface disposal wells. The relative merits of these, from the operator's and the environmental standpoints, will continue to depend on the availability and economics of suitable sites and on environmental constraints. Handling/disposal of these wastes is not considered to be within the scope of a waste disposal facility other than possibly a disposal well.

2. WATERWORKS AND SOFTENING SLUDGES

Again, these merit discussion primarily because of handling or disposal problems due to volume. Waterworks sludge consist of the suspended solids in raw water, plus material precipitated by chemicals added in the treatment process. They generally would not be considered hazardous and usually have no offensive odour.

However, the volume of the sludges is considerable, the handling may be difficult, and methods of disposal suited for small quantities of such material are not suited for massive amounts.

One municipality reported quantities of 1800 tonnes of softener sludge containing about 10% solids (calcium carbonate) being discharged to the river twice a year. No other municipalities reported water treatment sludge disposal.

Conventional management of lime sludges from settling ponds is as follows:

- dewater to reduce moisture content; then
- dispose of or re-use dewatered sludge.

Dewatering is usually carried out on land adjacent to the waterworks, using lagoons, with supernatant removal to facilitate drying. While sludge is being accumulated in one lagoon, other lagoons are permitted to air-dry. This air-drying will produce sludge up to about 50% solids, which is easier to handle. Mechanical dewatering can also be employed, using centrifuges, belt filters, vacuum filters and the like.

Disposal of dewatered sludge is practicably achieved by land-filling at municipal landfills. Re-use of the sludge is possible and has in some areas taken forms such as:

- use in constructing the berms for dewatering lagoons

- use in agriculture on soils requiring calcium carbonate addition

- recalcining to form hydrated lime, which may be used for water softening (generally applicable only in large plants)

- use as a neutralizing chemical at other waste or chemical treatment facilities.

Generally speaking, these techniques are again not considered to be within the scope of a hazardous or chemical waste disposal facility because the major problem with the waste is "amount" rather than "properties".

3. ON-FARM HANDLING OF AGRICULTURAL CHEMICALS

Wastes generated in the industrial use or production of herbicides and pesticides have been surveyed. On-farm wastes, in the form of residues in herbicide and pesticide containers have not been included in the survey.

To provide some insight into the volume of wastes involved, herbicide usage in Saskatchewan has been estimated using Manitoba data (18) and the container disposal problem problem has been quantified based on Florida findings (19):

1981 Estimated Saskatchewan Herbicide Usuage

Herbicides	(tonnes/year)
2-4-D Compounds	2 467
MCPA Compounds	670
Others (excluding wild oat herbicides)	773
Total (excluding wild oat herbicides)	3 910

1981 Estimated Saskatchewan Container Wastes Residues

Residue (.1% of container volume) = 4 tonnes/year
Containers (20 L) = 450 tonnes/year
(based on 196 000 containers)

The preceding synthesized values exclude pesticides and wild oat herbicides.

Because this waste is partly dispersed over Saskatchewan's farms (some 70 000 by Statistics Canada's 1976 data) and partly collected for disposal, it presents a special problem in establishing its whereabouts, collecting, and controlling it.

Although container decontamination and waste treatment is feasible, a mechanism for safely and economically collecting this waste for disposal is considerably more complex than that for disposal of localized factory wastes. The public and occupational health implications of assembling, stockpiling and

transferring these containers from the use site to the treatment site impose severe constraints on formulation of any collection strategy.

4. ASH

The largest industrial waste stream in Saskatchewan is power generation ash (700 000 tonnes/year were reported).

Unlike water treatment sludge, handling is not difficult, but the volume is very large. In general this material is disposed of by conventional landfilling.

Some fly ash is used in production of concretes. Fly ash also has potential as a solidification agent for liquid wastes. Fly ash is not generally amenable to treatment prior to ultimate disposal.

5. MERCURY-CONTAMINATED WATER

Mercury-contaminated process water is produced continuously and in sufficiently large quantities (400-500 tonnes/day) that transport to any off-site disposal or treatment facility is impractical. Disposal has generally been to surface water or deep well injection. The acceptable level of mercury in surface water is based on socio-economic as well as environmental judgement. While process changes can effect reductions in mercury content, the waste water is not generally amenable to treatment prior to disposal.

6. SLAG

Metal processing slag is typically produced in large volume - hundreds of tonnes per day - and is typically either used as raw material in mineral products, used as road fill or landfilled.

Again, the major disposal problem is amount rather than properties. Whether disposal at a specialized facility is preferable to land disposal would depend in large part on the composition of other materials at the facility and their potentials for beneficial or harmful interaction with slag constituents. This stream too is not generally treated prior to disposal.

7. HOUSEHOLD WASTES

It is recognized that household wastes can include a variety of problem materials,such as pesticides, medical preparations, electrical appliances and automotive materials.

Cleaning agents and cosmetics contain toxic solvents and heavy metals. Other problem compounds include deodorizers, disinfectants (napthalene, phenols), pesticides, laundry products, paint, polish and preservatives (20).

The per capita amount of such wastes is extremely difficult to quantify as discards are small, random and undocumented. Because of the small volumes, their scattered nature, and the impracticality of sorting them for separate treatment, household chemical wastes were excluded from consideration in the inventory.

8. OIL AND GAS DRILLING WASTES

The "Inventory of Hazardous Wastes in the Northwest Region", (16), has identified significant waste volumes for this industry. These are primarily drilling mud, brine, oily tank sludges and sulphides. Lesser amounts of chemical wastes and lubricating oils are produced.

The 1979 report predicts 290 000 tonnes/year of drilling mud waste, disposed of in pits at well sites. Brine and some sulphides are generally deep-well injected. Sulphide may also be incinerated or released to surface water, while oil containing wastes are used for road oiling, re-refined or landfilled.

9. UREA - FORMALDEHYDE WASTES

No firm reported these wastes either in questionnaire returns or on follow-up. Disposal of these wastes has presented occasional problems to date. Methods that have been recommended include:

- bagging loose foam in garbage bags and burying in municipal landfill sites
- reacting the foam ingredients in drums and burying them
- burying loose foam.

The major problem in disposal is control of urea formaldehyde dust. Merely dumping the wastes will spread this irritant material.

No data is available on leachability of the waste to the water table. (Private Communication, 1982, NRC).

APPENDIX II

SASKATCHEWAN ENVIRONMENT

CHEMICAL & INDUSTRIAL WASTES AND WASTE OIL SURVEY

(SAMPLE - "A" VERSION)

SASKATCHEWAN ENVIRONMENT
CHEMICAL & INDUSTRIAL WASTES AND WASTE OIL SURVEY A

A. COMPANY DATA

1. XYZ Chemicals Incorporated SIC # 3780
2. 999 Main Street
   Anywhere, Saskatchewan
   S0S 1Z1
3.
4. Questionnaire Completed by_____

   Title_____

   Date_____

5. Type of Business
   [ ] manufacturing
   [ ] distributing
   [ ] retail
   [ ] other _____

B PROCESS DATA (to be completed by process industries)

1. Raw Materials _____ Amount Per Year _____

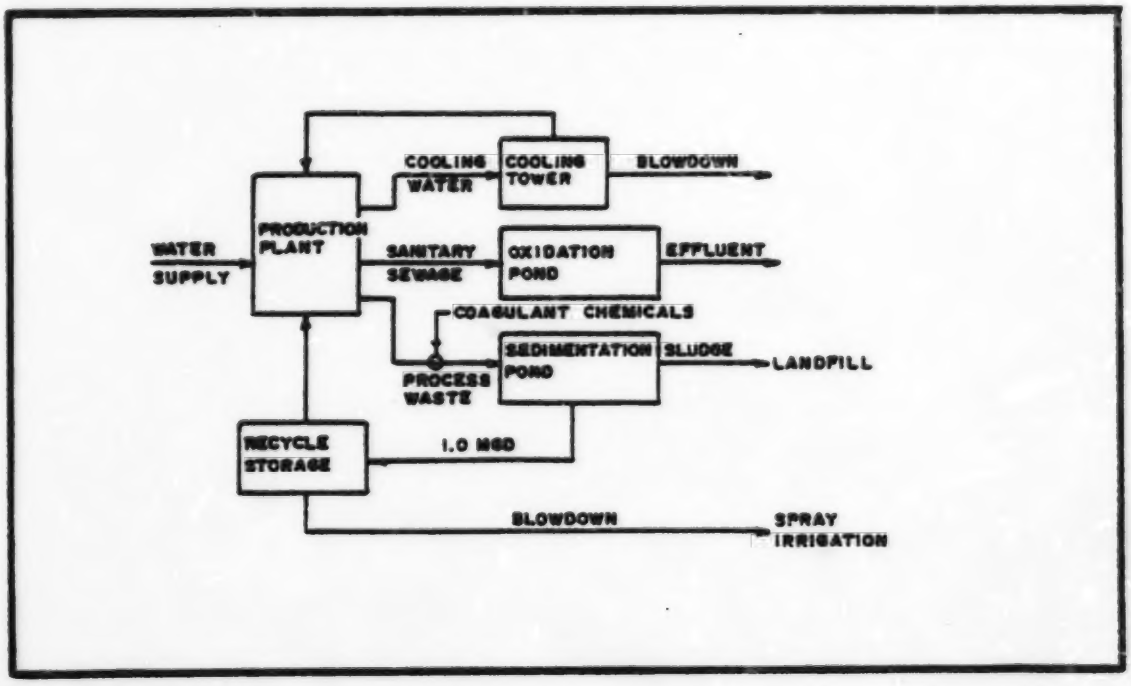
2. Products (and by-products) Amount Per Year

B. PROCESS DATA - cont'd

3. Describe your manufacturing process briefly.

4. To clarify above if required (Question B.3) provide a process flow diagram of your process operations showing where wastes are produced.

Example:



B PROCESS DATA - cont'd

4.

Your process flow diagram

C. WASTES SURVEY

Wastes are all solids, liquids, oils, and sludges generated at your facility and disposed of on your property, hauled for disposal to a municipal or industrial landfill, dump, waste treatment or storage facility or recycled. Included are process liquid wastes discharged to a sewer but not liquids from washrooms and floor drains or uncontaminated proces water.

1. Waste Types & Sources

Please identify waste streams, their sources within your process, the quantity of these wastes and frequency (hourly, weekly, monthly, yearly,....), and whether these values are estimated or measured.

	Waste Type	Source	Quantity	Frequency	Estimated or Measured ?
Example:	Oily Sludge	Tank Bottoms	5000 gals.	per month	measured
i)					
ii)					
iii)					
iv)					
v)					
vi)					

2. Using the same item numbers as above (eg. i, ii, etc.) please describe the composition of each waste stream.

	General Description of material contained in each waste stream	Concentration or percentage of material contained	Other Major contaminants
Example:	oil & grit	- 85% oils - 500 mg/ suspended solids	chromium, zinc
i)			
ii)			
iii)			
iv)			
v)			
vi)			

C. **WASTES SURVEY** - cont'd

3. Again using the corresponding item numbers as in questions 1 & 2 please indicate if known where and how the waste streams identified are disposed of. Disposal methods could include landfill, lagoon, incineration.

	On-Site Disposal	or Off-Site Disposal	Disposal Method	If off-Site Disposal: Hauler	Disposal Site Operator
Example:		X	municipal landfill	ABC Haulage 123 Main St. Regina, Sask.	Regina Landfill
i)					
ii)					
iii)					
iv)					
v)					
vi) v					

4. If any on-site pretreatment is carried out on the above waste streams please identify:

Example: settling lagoon

i)

ii)

iii)

iv)

v)

vi)

C. **WASTES SURVEY** - cont'd

5. Do you propose to expand your facility? Yes[ ] No [ ]
If so, what are the estimated increases in wastes quantities:

	Type of Expansion	Year	Size	Projected Wastes
Example:	Tank Farm	1983	500,000 gals	tank bottoms 20% increase
i)				
ii)				
iii)				
iv)				
v)				
vi)				

PART D - SUPPLEMENTARY INFORMATION

The following questions are intended to provide information on wastes, which may have been omitted from Part C, including those which are generated either in small quantities, or at infrequent or irregular intervals. Please disregard waste streams already included in Part C.

Do you generate wastes from the following types of activities or sources? If so, please indicate waste quantities, characteristics and current method of disposal.

		QUANTITY/MONTH (lbs., kgs., imp. gal. or litres)	QUANTITY ESTIMATED OR MEASURED?	CHARACTERISTICS	DISPOSAL METHOD
a)	Oily wastes from equipment operation/ maintenance or drainage interceptors				
b)	Waste water treatment sludge (excluding domestic sewage treatment)				
c)	Air pollution control equipment				
d)	Degreasing or cleaning operations				
e)	Cleanout of lagoons or disposal pits				
f)	Off-Specification products				
g)	Polychlorinated Biphenyls (PCB's) or PCB equipment - please indicate storage and disposal quantities				

FROM _____

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Edmonton, Alberta
T5S 1K9

Attention: Mr. H. J. Bourque, P. Eng.

APPENDIX III

GARAGES AND SERVICE CENTRES

APPENDIX III

GARAGES AND SERVICE CENTRES

Chemical wastes generated by garages and service stations consists mainly of oil and solvents. These are being disposed of by re-refining, deposition on property, and discharge to oil and grease interceptors.

The principal of operation of an oil and grease interceptor is to retain oil, grease, solvent, and grit by gravity separation from water-based wastes and to allow the discharge of water to sewers or septic tanks and tile fields. Periodic pumping of the interceptor contents is required.

A poorly maintained interceptor, full of oil or solvent, will continue to function but will allow the discharge of oil or solvents to the sanitary sewer or septic system. Such conditions are cause for concern by municipalities involved in the control of waste discharge to sanitary sewers.

Discussion with two municipalities (Regional Municipality of Peel and Regional Municipality of Halton) who routinely inspect service station interceptors indicate that there is great variance in maintenance practices.

In view of the lack of available data in Saskatchewan, "The Annual Survey of Garages and Automotive Service Centres" (21) by the Regional Municipality of Peel, Ontario was consulted.

This survey investigated interceptors at 524 garages, service stations and truck depots. The problems noted were:

- 13% of facilities had interceptors overflowing with oil.
- 3% had interceptors overflowing with solvents.
- 7% washed floors with solvents.
- 10% did not have interceptors.
- 10% did not have floor drains.

The "Saskatchewan Waste Oil Study" (2) indicates some 7000 tonnes of waste oil are generated by automotive servicing facilities. The study also reports that landfill disposal accounts for 1/3 of the generated waste. Discharges to oil and grease interceptors or sewers are not reported, but oil and grease interceptor pumpings would normally be landfilled and there should be no discharge to sewers.

If it is assumed that essentially all waste oil discharge to landfills reported in the "Waste Oil Study" (2) is from interceptor pump-out, then the total oil quantity is 2300 tonnes/year. Noting however from the Peel statistics that 13% of interceptors are overflowing oil, then a rough estimate would be that 340 tonnes/year of oil is overflowing to sewer systems and that the oil quantity should be 2640 tonnes/year instead.

It should be noted that the "Saskatchewan Waste Oil Study" reported quantities of oil. Interceptor pumpings are generally a mixture of water, oil and grit. The actual "pump-out" quantity is roughly estimated at 25 000 tonnes assuming pumpings contain 10% oil.

POOR

QUALITY

ORIGINAL